

AD-A214 459

DTIC FILE COPY



Research Product 90-01

Multipurpose Arcade Combat Simulator (MACS) Basic Rifle Marksmanship (BRM) Program

October 1989

**Fort Benning Field Unit
Training Research Laboratory**

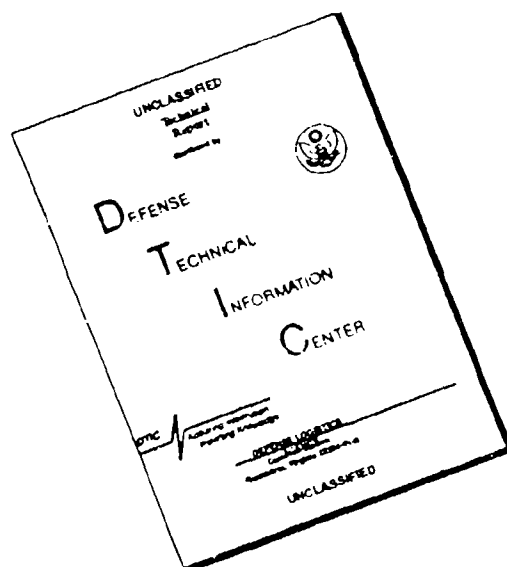
DTIC
ELECTE
NOV 16 1989
S B D

U.S. Army Research Institute for the Behavioral and Social Sciences

Approved for public release; distribution is unlimited.

89 11 15 003

DISCLAIMER NOTICE



THIS DOCUMENT IS BEST QUALITY AVAILABLE. THE COPY FURNISHED TO DTIC CONTAINED A SIGNIFICANT NUMBER OF PAGES WHICH DO NOT REPRODUCE LEGIBLY.

U.S. ARMY RESEARCH INSTITUTE FOR THE BEHAVIORAL AND SOCIAL SCIENCES

**A Field Operating Agency Under the Jurisdiction
of the Deputy Chief of Staff for Personnel**

EDGAR M. JOHNSON
Technical Director

JON W. BLADES
COL, IN
Commanding

Research accomplished under contract
for the Department of the Army

Litton Computer Services

Technical review by

Kenneth L. Evans
Margaret Salter

NOTICES

FINAL DISPOSITION: This Research Product may be destroyed when it is no longer needed.
Please do not return it to the U.S. Army Research Institute for the Behavioral and Social Sciences.

NOTE: This Research Product is not to be construed as an official Department of the Army
document, unless so designated by other authorized documents.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1a. REPORT SECURITY CLASSIFICATION Unclassified			1b. RESTRICTIVE MARKINGS ---	
2a. SECURITY CLASSIFICATION AUTHORITY ---			3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution is unlimited.	
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE ---				
4. PERFORMING ORGANIZATION REPORT NUMBER(S) ---			5. MONITORING ORGANIZATION REPORT NUMBER(S) Research Product 90-01	
6a. NAME OF PERFORMING ORGANIZATION Litton Computer Services	6b. OFFICE SYMBOL (If applicable) ---	7a. NAME OF MONITORING ORGANIZATION ARI Field Unit at Fort Benning, GA		
6c. ADDRESS (City, State, and ZIP Code) 1300 Villa Street Mountain View, CA 94041		7b. ADDRESS (City, State, and ZIP Code) P.O. Box 2086 Fort Benning, GA 31905		
8a. NAME OF FUNDING/SPONSORING ORGANIZATION U.S. Army Research Institute for the Behavioral and Social Sciences	8b. OFFICE SYMBOL (If applicable) PERI-IJ	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER MDA903-88-C-0407		
8c. ADDRESS (City, State, and ZIP Code) 5001 Eisenhower Avenue Alexandria, VA 22333-5600		10. SOURCE OF FUNDING NUMBERS		
		PROGRAM ELEMENT NO. 63007A	PROJECT NO. 794	TASK NO. (322) 3306
		WORK UNIT ACCESSION NO. C3		
11. TITLE (Include Security Classification) Multipurpose Arcade Combat Simulator (MACS) Basic Rifle Marksmanship (BRM) Program				
12. PERSONAL AUTHOR(S) Broom, John M.; Champion, David F.; Greene, William H.; Martere, Ronald F.; Purvis, Jamie W.; and Sills, Edward G.				
13a. TYPE OF REPORT Interim	13b. TIME COVERED FROM 88/01 TO 89/07	14. DATE OF REPORT (Year, Month, Day) 1989, October	15. PAGE COUNT 92	
16. SUPPLEMENTARY NOTATION Seward Smith, Contracting Officer's Representative				
17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)	
FIELD	GROUP	SUB-GROUP	Computer Simulation, Instructional Materials, Rifle Marksmanship, Training Aid	
05	06			
19	06			
19. ABSTRACT (Continue on reverse if necessary and identify by block number) This document contains a description of the Basic Rifle Marksmanship (BRM) program of the Multipurpose Arcade Combat Simulator (MACS) system, along with a record of the measures taken, standards used, underlying instructional methodologies, a statement of the technical limitations of the system, and copies of programming flow charts. The information is for use by personnel who may be involved in future developmental work on the MACS system and for those who must demonstrate and explain the BRM program.				
20. DISTRIBUTION/AVAILABILITY OF ABSTRACT <input checked="" type="checkbox"/> UNCLASSIFIED/UNLIMITED <input type="checkbox"/> SAME AS RPT. <input type="checkbox"/> DTIC USERS			21. ABSTRACT SECURITY CLASSIFICATION Unclassified	
22a. NAME OF RESPONSIBLE INDIVIDUAL Seward Smith		22b. TELEPHONE (Include Area Code) (404) 545-5589	22c. OFFICE SYMBOL PERI-IJ	

**Multipurpose Arcade Combat Simulator (MACS)
Basic Rifle Marksmanship (BRM) Program**

**John M. Broom, David F. Champion, William H. Greene,
Ronald F. Martere, Jamie W. Purvis,
and Edward G. Sills**
Litton Computer Services

**Field Unit at Fort Benning, Georgia
Seward Smith, Chief**

**Training Research Laboratory
Jack H. Hiller, Director**

**U.S. Army Research Institute for the Behavioral and Social Sciences
5001 Eisenhower Avenue, Alexandria, Virginia 22333-5600**

**Office, Deputy Chief of Staff for Personnel
Department of the Army**

October 1989

**Army Project Number
2Q263007A794**

Education and Training

Approved for public release; distribution is unlimited.

FOREWORD

The Multipurpose Arcade Combat Simulator (MACS) is an inexpensive, part-task weapons trainer that was developed to overcome the training problems encountered because of insufficient facilities and too few instructors. Because it uses mostly off-the-shelf components, MACS is substantially lower in cost than other available training devices, although it is equally effective. While current interest is focused primarily on its use as a rifle marksmanship trainer, MACS was designed so that the basic hardware could be used to provide training on a variety of weapon systems.

This report describes the Basic Rifle Marksmanship (BRM) software designed for use with the MACS system. An overview of the software is presented, followed by a discussion of the instructional design of the program. Presented in detail are discussions of the feedback provided on marksmanship fundamentals, derivation of performance standards, skill tests used to determine appropriate starting levels, and program options that may be accessed through the menu.

Patented in 1986, MACS is a product of the U.S. Army Research Institute for the Behavioral and Social Sciences Fort Benning Field Unit, which conducts research on training and training technology with particular emphasis on individual and small team skills in the Infantry arena. The research task that supports this mission is titled "Developing Training for Individual and Crew-served Weapons" and is organized under the "Training for Combat Effectiveness" program area. The U.S. Army Infantry School under a Memorandum of Understanding (9 December 1987) and the U.S. Army Training Support Center under a Training Device Need Statement for MACS approved in 1984 provided sponsorship for the MACS research program. The MACS system software described in this report is being fielded Army-wide by the Training Support Center at Fort Benning, Georgia.



EDGAR M. JOHNSON
Technical Director

MULTIPURPOSE ARCADE COMBAT SIMULATOR (MACS) BASIC RIFLE MARKSMANSHIP (BRM)
PROGRAM

CONTENTS

	Page
Introduction	1
Instructional Design of the BRM Program	2
Summary of the BRM Program	5
BRM Program Feedback	7
Aiming and Shot Location	8
Steady Position and Trigger Squeeze	12
BRM Program Standards	13
BRM Program Skill Tests	14
BRM Program Menu and Options	16
Light Pen Alignment Program	16
Sight Alignment, Aiming, and Grouping Program	17
Wind Speed	18
Call Your Shot	18
Targets at 250 M	18
Discussion	18
Summary and Recommendations	19
References	21
APPENDIX A. SUMMARY DESCRIPTION OF LEVELS	A-1
B. CRITERIA TARGET AREAS FOR AIMING AND SHOT LOCATION	B-1
C. USERS' FLOW CHART FOR THE MARKSMANSHIP SKILL TESTS	C-1
D. PROGRAMMING FLOW CHART FOR THE BRM PROGRAM	D-1
E. PROGRAMMING FLOW CHART FOR THE SIGHT ALIGNMENT AND GROUPING PROGRAM	E-1
F. BRM PROGRAM DOCUMENTATION	F-1

CONTENTS (Continued)

	Page
APPENDIX G. MACS BRM CARTRIDGE PROGRAM LISTINGS	G-1
H. MATHEMATICAL FORMULAE	H-1

LIST OF TABLES

Table 1. Criteria values of Standard Deviation (SD) and Range (R) for ratings of Steady Position (SP) and Trigger Squeeze (TQ)	12
H-1. Standards in the BRM program for diagnostic scores and shot location	H-1

LIST OF FIGURES

Figure 1. A representation of a 2.15 x 1.66 cm section of screen, showing the target area and the ratings that are awarded for mean points of aim and shots located at different distances from the center of mass. The point 0,0 would be at the center of an observed target.	9
2. A representation of a 2.15 x 1.66 cm section of screen, showing the target areas and ratings awarded for mean points of aim and shots located at different distances from the center of mass for unsupported fire	11
B-1. Comparison between mathematically defined target area and the effective target area	B-2

viii



Accession For	
NTIS GRA&I	<input checked="checked" type="checkbox"/>
DTIC TAB	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
Justification	
By	
Distribution/	
Availability Codes	
Dist	Avail and/or Special
A-1	23

MULTIPURPOSE ARCADE COMBAT SIMULATOR (MACS)
BASIC RIFLE MARKSMANSHIP (BRM) PROGRAM

Introduction

The MACS BRM program has been under development since 1985. The BRM program is intended for school instruction in basic rifle marksmanship, as well as for remedial and sustainment training. The program has been used with particular success in helping the average and below average shooter attain proficiency in marksmanship skills (Evans, 1988). The purpose of this paper is to describe the latest version of the BRM program (Version 8901). The program's instructional design, performance measures, and rationale behind the standards are described in detail. This paper will be of interest to individuals engaged in MACS developmental work and others who are involved in demonstrating the BRM program.

The MACS system is a low-cost, computer-based, part-task weapons trainer. The system components include a weapon (e.g., a demilitarized M16 rifle) with an optical focus light pen attached to the barrel, a Commodore 64 computer, and software appropriate to the characteristics of the weapon. The system allows shooters to practice basic skills by firing at targets at scaled ranges that are displayed on a computer screen. Diagnostic feedback is provided. The program has been validated as a teaching device (Evans, 1988).

The MACS BRM program presents stationary targets only, set at ranges between 50 and 300 meters. The program includes an initial assessment of the shooter's marksmanship skill level, followed by nine progressively more difficult levels of training. Specific performance standards are set for each level. At the end of each level, the shooter's performance is compared to standards within the program. At this point, a shooter may advance to the next level, stay at the same level, or regress to a lower level.

The program is designed to be used with an instructor present; however, one instructor can monitor several systems concurrently, since the on-screen text is largely self-explanatory to the user. As long as a soldier is making satisfactory progress, the computer screen border remains black in color. The instructor's attention is drawn to any soldier having difficulty by a change in border color. The program is designed to help the instructor diagnose the shooter's problems and provide corrective guidance to the soldier. Diagnostic measures include steady position, aiming, trigger squeeze, and breath control. Shot groups for each range are displayed at the end of each firing sequence or level in the program.

The program begins with a marksmanship skill test, which is used to zero the system electronically, and to determine the appropriate starting level for the shooter. Shooters beginning at a low level receive heavily augmented feedback and, as progress is made from level to level, this feedback is gradually withdrawn. When shooters reach Level 7, they are performing with feedback that simulates that found in actual record fire tests and they are firing to record fire standards. Levels 8 and 9 take the shooters beyond basic record fire requirements and prepare them for the Advanced Rifle Marksmanship (ARM) course.

The BRM program is written in 6510 Assembler and BASIC. Flow charts, program documentation, and program listings are presented in Appendixes C through G.

Instructional Design of the BRM Program

When novices learn to shoot, they frequently flinch or blink as they pull the trigger. When flinching occurs in anticipation of the discharge of the weapon rather than following the discharge, it disturbs the lay of the weapon. Thus, in live fire, a new shooter has to learn to control any tendency to flinch and, concurrently, master the fundamentals of marksmanship that enable accurate shooting.

Because the rifle used with the MACS BRM system has no flash, recoil, or cartridge ejection when fired, no anticipatory flinch is induced. This enables the shooter to concentrate on developing the psychomotor skills needed to master the fundamentals of marksmanship. These are maintenance of a steady position, controlled breathing, correct aiming, and good trigger control (Osborne & Smith, 1985; U.S. Army Infantry School (USAIS), 1984).

Evans (1989) has demonstrated that rifle marksmanship simulators that have no recoil train as effectively as those that incorporate it; and he has pointed out that the lack of recoil is of particular advantage to the instructor because it enables errors arising from poor trigger squeeze to be identified. In live fire, such errors are often confounded with errors arising from anticipatory flinch. Poor trigger control has been shown to cause more target misses than does failure to master each of the other fundamentals (Osborne & Smith, 1985; USAIS, 1984).

The Army teaches soldiers to aim at the center of mass of a target. The rationale for this is that if soldiers always aim at the center of mass of a stationary target, they have a higher chance of hitting that target. However, the overall purpose of basic rifle marksmanship training is to enable the soldier to hit the enemy in combat. For this reason, the minimum standard set in record fire is to hit 23 out of 40 targets; the hits are credited irrespective of the location of the shots relative to center of mass. Thus, two separate criteria exist (aim center of mass and hit the target), and these criteria are not always compatible.

For example, a shot that strikes an E-type silhouette in the head is located farther from the center of mass of that target than a shot that just misses the target but is in the horizontal plane of the center of the target. By the criterion of aim center of mass the miss is a better located shot than is the head shot. However, by the hit or miss criteria, the head shot is clearly better. The MACS BRM program uses both criteria. Progress within a level is governed by a requirement to hit a set number of targets, either at each range or in total. Progress from level to level is determined by the accuracy of shots relative to the center of mass of the targets. Therefore, a soldier who progresses through the levels is not only hitting an adequate number of targets, but is hitting targets within reasonable proximity to center of mass.

Many scholars, and notably Smith and Smith (1966), argue that, in essence, the act of learning is the adjustment of one's activities in the

light of feedback received. Thus in learning to shoot, one fires, observes the result (target does or does not fall), makes adjustments, and fires again; the objects being to reduce discrepancies between the goal (hitting the target) and the result (bullet strike - if this is observed). Although a shooter can learn independently, the learning process is speeded by the provision of extrinsic, augmented feedback, such as sure knowledge of where the missing shot went, and guidance on what one did wrong. Bilodeau and Bilodeau (1958) have shown that for some motor skill tasks, the rate of learning is proportional to the number of trials providing extrinsic feedback, and that ten trials each with extrinsic feedback can teach as rapidly as 100 trials with feedback after every tenth trial.¹

Bilodeau (1966) describes three types of augmented feedback that have been demonstrated to help in such tasks; these are concurrent feedback, information feedback, and learning feedback. The MACS BRM program uses all three. Concurrent feedback is artificial augmentation of the effect of a response. In the initial levels of the BRM program (Levels 1 and 2), this is provided by a cross showing bullet strike and the words HIT or MISS appearing on the screen. Information feedback is feedback given immediately after a trial and is an objective assessment of performance. In the initial levels of the program, such feedback is given after every shot and takes the form of a screen showing ratings of the shooter's performance on the four fundamentals of marksmanship (steady position, aiming, trigger squeeze and breath control), as well as a replay of the front sight post coming onto target. Learning feedback is delayed feedback provided at the end of a series of trials. The MACS BRM program provides summary screens showing overall performance at the end of each level.

Because augmented feedback is not available in actual combat, it is important that the shooter does not become dependent upon it. For example, the showing of bullet strike on the screen when the shooters miss aids in adjusting their subsequent shots, but in combat they may not know where the round impacted. Therefore, as the shooter progresses, feedback is gradually withdrawn so that in Levels 3 and 4, detailed single-shot feedback is only given for a poor shot and in Levels 5 and 6, feedback is given only in summary form. By the time shooters reach Level 7, they have learned to operate with the same amount of feedback that they would receive on a record fire range. Precise details of the feedback at each level are in Appendix A and are discussed in the descriptions of the levels (see p. 5). The withdrawal of feedback gradually) and only after the shooter has manifested a reasonable level of proficiency agrees with conclusions reached by Stammers and Patrick (1975) in their comprehensive discussion of the subject.

The MACS BRM program is a self-paced training system that enables individual shooters to progress at a rate appropriate to their initial skill

¹Lavery (1962) argues that performance can contain both variable error and constant error, where variable error is the result of random factors, and constant error is the result of the trainee's behavior. He points out that provision of feedback after every trial can cause a trainee to try and correct for "variable error" and therefore concludes that feedback should only be given at the end of a block of trials. This view is not subscribed to in the design of the MACS BRM program.

levels and aptitudes for the task. When new shooters begin on the system, they are given a test that assesses the level at which they should begin. The program then may start them at any level between 1 and 5. It is only a very competent shooter, however, who begins at Level 3 or above. This test is discussed in detail subsequently.

The program is designed to enable self-pacing. To this end, information screens at the start of each level inform the shooter of the number of targets that will appear, whether they are timed or untimed targets, the position the shooter should adopt (supported or unsupported), and the standard the shooter must meet (e.g., in Levels 1 and 2, to hit two out of three targets at each range). At the start of Levels 1 and 2 only, additional screens instruct the shooter to aim at center of mass and teach what is meant by center of mass. When shooters fail to meet the standard, they are told on screen that they must refire; they are informed when they have refired successfully. Similarly, if they are sent back a level or made to repeat a level, they are told on screen that this is happening, and why it is happening.

Before a novice can use the MACS BRM program to develop marksmanship skills, three basic concepts must be understood. These are correct sight alignment, correct placement of the front sight post on the target, and what is meant by a tight shot group. However, because not all users are novices, these concepts are taught in an optional introductory program that the instructor can access via the system menu. This program is described in the section on optional programs and features.

For the expert marksman, a motivational element is present in the program. At the end of level 9, the top ten shooters may record their initials on the screen upon completion of the level. The recording of shooter's initials is designed primarily to encourage competition among those undergoing sustainment training.

The MACS BRM program is designed so that one instructor can monitor a number of shooters, firing on separate individual systems, simultaneously. This is achieved by making the program as self-explanatory as possible. As long as a shooter is making steady progress, the screen border remains black. Only when a shooter is having difficulty does the border change color. Therefore, instructors can scan rapidly down a row of monitors and determine where their individual attention would be best applied. The border color coding is as follows:

- A black border indicates that the shooter is making satisfactory progress.
- A red border indicates that the shooter is refiring targets at a particular range, or a part of a level.
- A blue border shows that the shooter has been made to repeat a level.
- A yellow border means that the shooter has been sent back a level.
- A purple border indicates either that the shooter is aiming off screen and pulling the trigger, or that the light pen is not reading properly.

When an instructor sees a border color that indicates a shooter is having difficulty, the level the shooter is on, the particular target within the level the shooter has reached, and the number of times the shooter has refired can be checked. This information is given in a small inset in the top left-hand corner of the screen. The on-screen feedback designed for the shooter is, of course, also available to the instructor to help diagnose the problem the shooter is having.

Summary of the BRM Program

A brief discussion of each of the nine levels is provided below. Optional features that may be used with some or all of these levels are described separately, as is the initial skills test. A summary level-by-level description of the program with details of feedback and standards is given in Appendix A. Program features, such as the initial skills test, are described elsewhere.

Levels 1 and 2 are designed to develop basic skills. The only difference between the two levels is that Level 1 is fired in the supported position and Level 2, unsupported. For Levels 1 and 2, detailed shot-by-shot feedback is provided. When the shooter fires at the target, HIT or MISS is indicated on screen and the bullet strike is shown by a cross. The shooter then receives a rating (EXCELLENT, GOOD, AVERAGE, BELOW AVERAGE, POOR) on three diagnostic measures (steady position, aiming, trigger squeeze) for the shot fired, and the location of the shot relative to center of mass of the target is rated. Breath control is rated O. K. or CHECK. The movements of the front sight of the rifle are replayed for a period of up to 6 seconds before trigger closure. Then the frame is briefly frozen to allow comparison of the final front sight position (shown in white) with the correct front sight position of the target (shown in black). Three targets are presented at each of six ranges (50 to 300 m). F-type targets are presented at 50 and 100 m, E-type targets at all other ranges. After each set of three shots, a screen showing the three-round shot group on a single target is provided. At the end of the 18 shots, a summary of the mean ratings for steady position, aiming, trigger squeeze, breath control, and shot location is presented. As shooters go through each level, internal algorithms determine whether they should refire targets at a given range, and at the end whether they should be permitted to advance to the next level.

Levels 3 and 4 introduce shooters to timed targets and to the need to adjust their aims for targets at different ranges. To this end, targets at different ranges are presented in a random order. Concurrently, some of the feedback is withdrawn. HIT and MISS no longer appear on the screen, and diagnostic information and replay are provided only when the shooter fires badly (rated POOR by one of the diagnostic measures or BELOW AVERAGE on shot location). The main difference between the levels is that Level 3 is fired in the supported position and Level 4, unsupported. There is a slight relaxation of standards for 250- and 300-m targets when they are fired at from the unsupported position. Information and replay are provided only when the shooter fires poorly (rated POOR by one of the diagnostic measures or BELOW AVERAGE on shot location).

Levels 5 and 6 provide practice for record fire. The number of targets at each range and their exposure times are the same as those used in record fire, but the order of target presentation is randomized. In Level 5, bullet strike is still shown by a cross for both misses and hits; in Level 6, it is shown for misses only. At these levels, diagnostic feedback and replays are no longer provided. Only two measures are taken, a count of hits and misses, and the measure of shot location. The rationale for this is that good shot location is largely the result of having a steady position, accurate aiming, and good trigger squeeze. These have been emphasized for four levels, and the shooter should by now have an understanding of the causes of poor shots. Levels 5 and 6 are both divided into two parts; the first 20 shots are fired from the supported position and the next 20, unsupported. Shooters must hit 15 out of 20 targets on the first part before proceeding to the second part, which also requires 15 out of 20 hits; thus shooters are being trained to sharpshooter standard (30/40). At the end of each level, shooters are graded according to the number of targets they hit (Expert 36/40, Sharpshooter 30/40, Marksman 23/40, or Unqualified). Because training is to sharpshooter standard, shooters are graded marksman if they have to refire one of the positions.

Whereas the criterion for getting through the two parts of Levels 5 and 6 is the number of hits obtained, the mean rating of shot location determines whether the shooter progresses to the next level, refires the same level, or regresses one level. Thus shooters who have hit the 30 out of 40 targets needed to get through a level may still be regressed one level if the mean rating of shot location, over all 40 targets, is POOR. This is reasonable because an average rating of POOR indicates that they are just nicking the targets rather than hitting them squarely.

Level 7 (record fire) is the culmination of the previous six levels of training and is an on-screen re-creation of actual record fire. It is identical to the previous level (Level 6), but feedback is reduced to that which a shooter would receive on the record fire range, i.e., targets disappear when hit, or remain until their exposure time has elapsed (indicated by a whistle) and then disappear. Bullet strike is no longer shown, and no replays or diagnostic scores are given. Level 8 (rapid record fire) takes the shooter beyond the requirements for record fire. It is identical to level 7 in structure, but the exposure times of targets are reduced to two-thirds of the time allowed for record fire as an initial step in the transition to the engagement of moving targets, in the MACS Advanced Rifle Marksmanship (ARM) program (under development).

Level 9 (combat fire) is an attack/retreat scenario. Because up to five individually timed targets may appear on the screen simultaneously, and because new targets may appear as others are being engaged, it teaches shooters to maintain an awareness of their whole fields of fire even as they engage particular targets. Individual target exposure times vary but are similar to or less than those allowed for record fire. The level is divided into two parts, the first 40 shots being fired from a supported position and the second 40, unsupported. The shooter must hit 23 out of 40 targets on the first part before proceeding to the second part, which also requires 23 out of 40 hits. If shooters do not meet this standard, they must refire the position. At the end of each position, the shooter is graded Expert, Sharpshooter, Marksman, or Unqualified. Once a shooter has reached this level, the only measure taken is hit or miss. The locations of the shots

relative to center of mass of targets are no longer considered, and therefore there is no question of the shooters being sent back a level or being made to repeat the whole level.

BRM Program Feedback

The instructional design of the BRM program incorporates feedback for each shot fired in Levels 1 and 2, and for poor shots in Levels 3 and 4. Ratings are provided for each of the four marksmanship fundamentals: steady position, aiming, breathing, and trigger squeeze. In addition, a rating of shot location is provided. The first four measures are diagnostic, and assess the shooter's performance up to the moment of firing. The shot location measure assesses bullet strike in relation to center of mass.

The diagnostic and resultant scores are obtained as follows. The light pen reads the screen constantly and maintains a running memory (stack) of 127 readings¹. Immediately after trigger closure, the appropriate readings are extracted from the stack and the scores are calculated. These scores are then compared with criteria values to obtain the verbal ratings. The scores for each measure are described below.

The shot location score is determined by the radial distance between the location of the last light pen reading before trigger closure and the center of mass of the target.

The aiming score is determined by the radial distance between the mean point of aim (the average location of readings 45 through 7 (inclusive) before trigger closure) and the center of mass of the target. Because the light pen takes 60 readings per second, the aiming score is taken over a period of 0.65 seconds.

The steady position score is based on the standard deviation of light pen readings in the X and Y axes about the point of aim and is also taken over readings 45 through 7 before trigger closure. The greater the degree of wobble, the greater the standard deviations, and the lower the score awarded.

Since breath control cannot be directly measured, the ratings assigned to breath control are derived from the steady position score. The three highest steady position scores (EXCELLENT, GOOD, or AVERAGE) correspond to a breath control rating of O.K. The assumption is made that given a relatively steady position, breath control is adequate. If the position is relatively unsteady, as indicated by the two lowest steady position scores (BELOW AVERAGE and POOR), the breath control feedback is CHECK. The assumption is made that a poor steady position may be due to poor breath control, or to other factors. Breath control, as one of the four fundamentals of marksmanship, is emphasized in the feedback given to the soldier. Of course, the instructor observing the soldier in the act of shooting, will remain alert for other factors contributing to unsteadiness.

¹This should not be confused with the replay which is based on 256 readings taken with a sampling rate of 20 readings per second.

The trigger squeeze score is based on the range of readings in the X and Y axes about the point of aim, and is taken from reading 6 before trigger closure to reading 3 after trigger closure; that is, over 0.15 seconds. It should be noted that the trigger squeeze measure is not concerned with how rapidly or steadily the trigger is squeezed, but with whether or not the point of aim is disturbed. The actual algorithms used to compute all diagnostic scores are in Appendix H.

Aiming and Shot Location

The MACS BRM program contains separate standards for firing in the supported and unsupported positions; those for the supported position are more rigorous. A supported position is a "position which utilizes something other than the body to steady the weapon" (USAIS, 1984). The unsupported position assumes no support other than the body and the ground. The difference is that in the unsupported position the weight of the rifle is borne by the forearm, wrist, and hand, whereas in the supported position some object bears this weight. Thus shooters in a standing foxhole position, who use the ground to support their elbows, are defined as firing unsupported. If the rifle is bedded onto sandbags, then firing is termed supported.

Supported position. Underlying all targets that appear on the screen is a second, unseen, and mathematically defined target area that is analogous to a bull's-eye. The rings of this bull's-eye are defined in terms of radial distances (in pixels) from the center of mass of each target, with a correction to accommodate the rectangular shape of pixels (so that the unseen bull's-eye is close to circular on the screen), and adjusted to ensure that the areas defined as EXCELLENT and GOOD correspond closely to 2-cm and 4-cm circles on an E-type silhouette target scaled for 25 m.

This bull's-eye is of constant size, irrespective of the perceived size of targets. Figure 1 shows a representation of the unseen bull's-eye on a section of screen. The small rectangles represent the pixels on the screen. The mathematically defined midpoint of the target area is shown as point O,O. As can be seen, the target area is not centered perfectly on the midpoint, and even with a redesign of the shape of the area it could not be perfectly centered. This is because of the way the computer stores the values of odd-numbered pixels in the X axis, and is fully explained in Appendix B.

The midpoint of the mathematically defined target area is always set at the center of mass of each target seen on the screen. When a shot is fired at the target, and if the mean point is computed to be in the area designated GOOD, then the shooter receives a rating of GOOD for aiming. If the final light pen reading before trigger closure is from one of the six pixels labeled EXCELLENT, then shot location is rated as EXCELLENT. The mathematically defined target area is smaller than the 50- and 100-m targets, but larger than those at 150-m and beyond. For example, the 300-m target is only 5 pixels wide and 9 pixels high. Therefore, a shot can miss a 300-m target and still hit the underlying target area in the area rated as average. Because it is not intuitively obvious to the user how a miss can deserve a rating of AVERAGE in shot location, the shot location score is reported on the screen as a MISS. On-screen ratings of POOR through EXCELLENT are given only when the target has been hit. However, the computer maintains an internal record of the actual

rating, and this is included in the calculations for the summary feedback screens.

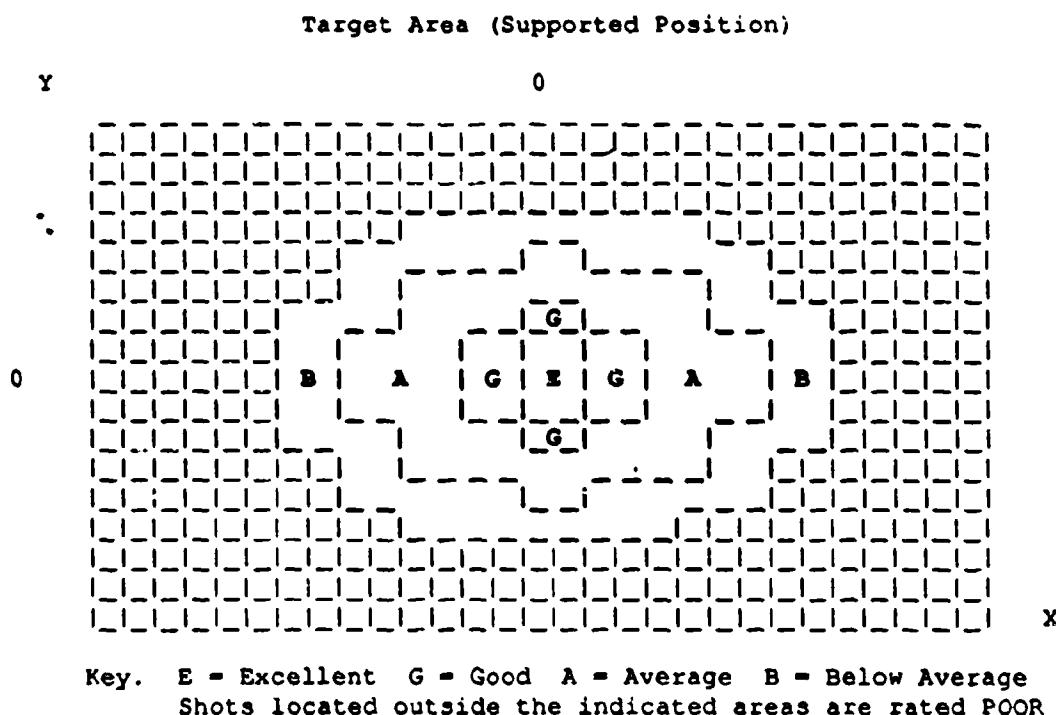


Figure 1. A representation of a 2.15 x 1.66 cm section of screen, showing the target area and the ratings that are awarded for mean points of aim and shots located at different distances from the center of mass. The point 0,0 would be at the center of mass of an observed target.'

The areas defined in the underlying bull's-eye target are best explained by relating them to circles on a target at 25 m. The area defined as EXCELLENT comprises 6 pixels. These 6 pixels occupy the same area as would a circle of 0.24 cm diameter on the screen. A circle of .24 cm diameter subtends an angle of 2.68 minutes of arc when viewed at 3 m, which is the eye to screen distance for using the MACS system. Viewed at 25 m, a circle of 1.95-cm diameter would also subtend an angle 2.68 minutes of arc. Thus were a shooter's shot location to be rated EXCELLENT on three consecutive shots, he could have fired the equivalent of a 2-cm, three-round shot group at 25 m. In a similar manner, we can calculate that the area defined as GOOD or better, equates to a circle of 3.73 cm diameter at 25 m, AVERAGE to a circle of 7.30 cm diameter, BELOW AVERAGE to a circle of 10.25 cm diameter, and POOR is greater than 10.25 cm.

'Actual pixels are longer in the Y axis than in the X axis (approximate ratio is 1.33:1); the on-screen target area is, therefore, more circular in shape than is shown.

The target areas were derived from two sources. First, 300 initial entry trainees fired a series of 250-m targets on MACS. The distances between bullet strike and the center of mass of the targets were recorded in numeric form and the mean and standard deviation (SD) of the numeric scores were calculated (Hunt et al., 1987). Arbitrarily, shots located within 1 SD either side of the mean were termed AVERAGE, shots located between 1 and 2 SDs above the mean were termed GOOD, and those over 2 SDs above the mean were termed EXCELLENT. Likewise, shots located between 1 and 2 SDs below the mean were termed BELOW AVERAGE, and those over 2 SDs below the mean were termed POOR. This yielded an underlying bull's-eye target that reflected the performance of novice shooters but was overgenerous as a training standard. The area rated GOOD or better, for example, equated to a circle of 4.64 cm diameter at 25 m.

The second source used was Field Manual 23-9 (Department of the Army, 1988), which contains guidelines for categorizing shot groups on a scaled E-type target at 25 m (fired from the supported position). These state that a 2-cm, three-round shot group "indicates no ... shooter error is involved," a 3-cm, three-round shot group represents "acceptable firing performance," a 4-cm, three-round shot group indicates that "shooter error" has occurred, and a 6-cm, three-round shot group indicates obvious error.

Using this information, a constant was added to the algorithms derived from the performance of the 300 trainees that resulted in the target area shown in Figure 1. The areas defined in Figure 1 as EXCELLENT and GOOD are the closest approximation that can be reached on the screen to circles of 2 and 3 cm diameter at 25 m. (For reasons discussed in Appendix B, odd-numbered pixels in the X axis always take the value of the pixel to their left. This means that no part of the area defined as GOOD in Figure 1 can be reduced without that part being eradicated. One cannot, for example, make the areas left and right of EXCELLENT just 1 pixel wide.) Scores of AVERAGE and below for shot location indicate that shooter error has occurred. The choice of the term AVERAGE to describe inadequate shooting was made with a view to encouraging the shooter. We may also note that the shooter who is rated average on shot location has in fact fired a little better than what was defined as average from the performance of the trainees. This is because the constant that was added to limit the area defined as GOOD, also reduced the areas designated AVERAGE and BELOW AVERAGE, in each case by approximately 40%.

It has been inferred that if shooters could consistently score EXCELLENT on shot location with MACS, they would be placing their shots within the equivalent of a 2-cm circle at 25 m. In fact, such consistency would exceed the technical limits of the system. This is because the light pen is not that precise. A light pen is judged to be correctly calibrated if it reads to within 2 pixels (+ or -) of a given pixel. In fact, a well grounded and correctly calibrated light pen does a little better than this, in that it rarely deviates more than 1 pixel in the Y axis. Because of these deviations, a shooter who consistently fires at the precise center of mass of a target will occasionally have his shot location rated as GOOD; similarly, GOOD shots will on occasions be rated EXCELLENT. Over an entire level of shooting, these deviations cancel out, so that summary screens are more accurate than are feedback screens on individual shots.

Unsupported position. The criteria for allocating ratings of shot location and aiming in unsupported fire are less rigorous than those for

supported fire. This is because firing from an unsupported position is more difficult than firing supported. The target areas are shown in Figure 2.

As may be seen, the area rated as EXCELLENT now comprises 10 pixels on the screen. Scaled out to 25 m, this may be equated to the area encompassed by a circle of 2.52 cm diameter. The area rated as GOOD or better has been increased to 42 pixels and equates to a circle of 5.16 cm diameter at 25 m. One implication of the larger target areas is that deviations in light pen readings have a reduced impact. Therefore, a shooter who consistently aims and fires at the exact center of mass of a target should receive single shot ratings of EXCELLENT with far greater reliability than occurs in the supported position. As with the supported position, the criteria were originally developed from the measured performance of the 300 trainees. These criteria were then modified by the introduction of the same constant that was used to reduce target areas in the supported position; thus the changes made are proportional to those made for the supported position.

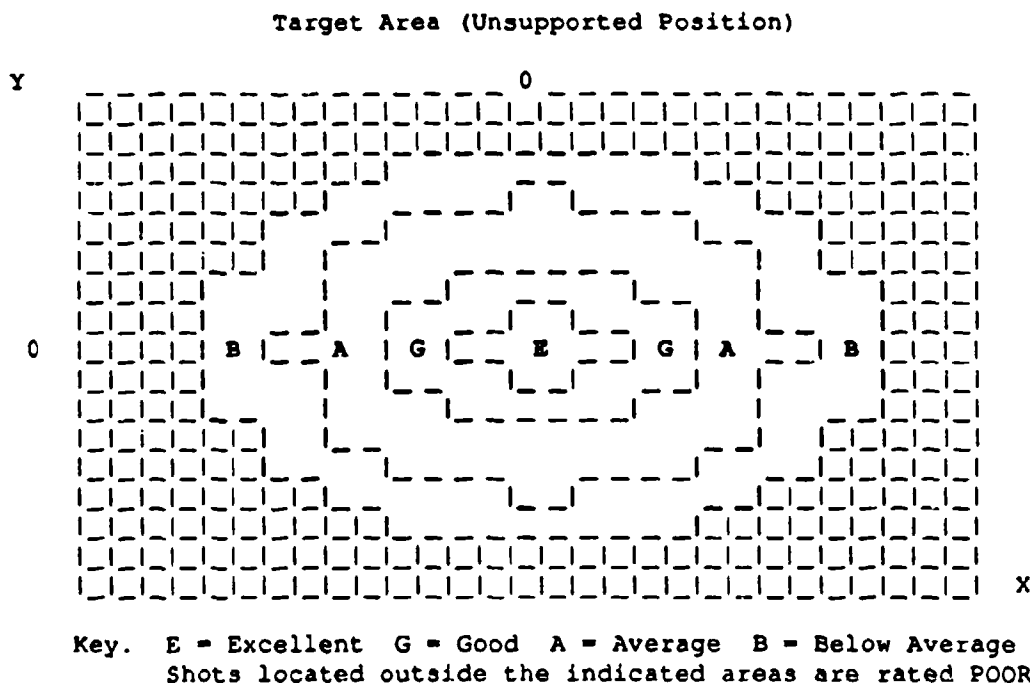


Figure 2. A representation of a 2.15 x 1.66 cm section of screen, showing the target areas and ratings awarded for mean points of aim and shots located at different distances from the center of mass for unsupported fire.'

'Actual pixels are longer in the Y axis than in the X axis (approximate ratio is 1.33:1); therefore on-screen target area is more circular in shape than is shown.

Steady Position and Trigger Squeeze

Steady position ratings for each shot are made based on the sum of the standard deviations of light pen readings in the X and Y axes (corrected for pixel shape), for readings 45 through 7 before trigger closure. The sum is then compared with criteria values. The criteria values were originally established using data collected from the group of 300 trainees referred to earlier. Subsequently, the correction factor for pixel shape was added, and this had the effect of inflating the Y-axis standard deviations. Therefore, the degree of dispersion (wobble) permitted for a shooter to earn a given rating is reduced. These tightened standards agree with the recommendations of subject matter experts (SMEs). The criteria used are given in Table 1.

Table 1.

Criteria Values of Standard Deviation (SD) and Range (R) for Ratings of Steady Position (SP) and Trigger Squeeze (TQ)

Ratings					
	<u>Excellent</u>	<u>Good</u>	<u>Average</u>	<u>Below Average</u>	<u>Poor</u>
Supported Position					
SP	0<SD<=2.5	2.5<SD<=5.0	5.0<SD<=8.0	8.0<SD<=10.5	10.5<SD
TQ	0< R<=2.5	2.5< R<=5.0	5.0< R<=8.0	8.0< R<=10.5	10.5< R
Unsupported Position					
SP	0<SD<=4.0	4.0<SD<=6.5	6.5<SD<= 9.5	9.5<SD<=12.0	12.0<SD
TQ	0< R<=4.0	4.0< R<=7.0	6.5< R<=11.0	9.5< R<=14.5	14.5< R

Trigger squeeze is measured over the 9/60 of a second period about the moment of firing. The readings used are from the sixth reading before to the third after trigger closure. Measurement is by taking the range of light pen readings in the X axis and in the Y axis (with the Y values corrected for pixel shape), adding the two ranges together, and comparing the resulting score with the criteria values (see Table 1). The mathematical procedures used to compute the steady position and trigger squeeze measures were adopted because of the need to minimize computer processing time. The more obvious method of computing the standard deviation and range from the radial distances between individual light pen readings and the mean point of aim was found to cause unacceptable delays in providing feedback.

In the supported position, the decision to use the same criteria for trigger squeeze as are used for steady position means that a shooter who is rated GOOD on steady position must hold the weapon even more steadily at the moment of trigger closure if he is also to obtain a GOOD on trigger squeeze. This is because the whole range of movement in the 9/60 of a second period about trigger closure must be equal to or less than the standard deviation of

movement in the preceding 36/60 of a second. These more rigorous demands mean that soldiers who wish to improve their trigger squeeze are forced to concentrate on maintaining the lay of the weapon as they pull the trigger.

In the unsupported position, the criteria for trigger squeeze and steady position diverge, the differences between them increasing with the descending order of ratings. This is done to make some allowance for the poorer novice shooter whose fundamental problem may be lack of strength or sufficient muscle tone to bear the weight of the rifle for extended periods, so that muscle fatigue induces tremor.

It should be emphasized here that MACS is a teaching device, designed to facilitate the development of the psychomotor skills necessary to fire the weapon accurately. It is not an analytic tool designed to measure precisely the degree to which shifts in the lay of the weapon are directly attributable to poor trigger control. In fact, although the range of movement that is measured at trigger squeeze may often be the result of poor trigger control, it may equally be nothing more than the range of movement that was present when steady position was measured. In other words, a poor trigger squeeze score can result from an unsteady position. This being acknowledged, let us also recognize that a soldier who concentrates on carefully squeezing the trigger while maintaining the point of aim, is learning to hold the weapon steadily, which is the object of the exercise.

The method of measuring trigger squeeze, and the criteria used to award ratings, were derived empirically. Earlier versions of the BRM program took the standard deviation of the movement, but SMEs judged this measure to be too insensitive. To increase the sensitivity, the range was substituted for the standard deviation. It was then found that the criteria originally derived from the performance of the IETs were too rigorous (SMEs could detect no differences in their own trigger squeeze between shots even though the ratings suggested great differences had existed). Thus, by trial and error, it was found that the steady position criteria combined with the range score gave a degree of sensitivity that was judged appropriate by SMEs.

A detailed explanation of the derivation of the steady position and aiming ratings may be found in Evans' (1988) review. The breath control rating is derived from the steady position measure. Steady position ratings from average to excellent correspond to a breath control rating of O.K., and the below average and poor ratings correspond to a breath control rating of CHECK.

BRM Program Standards

Progression through a level is determined by a simple count of the number of targets hit. A standard is set for each level, and an information screen at the start of the level tells the shooter what the standard is. The standards for each level are given in Appendix A. The instructional principle underlying this progression is that of overlearning. "Overlearning is additional practice after performance standards have been met," and its value is that it aids retention and "tends to prevent skill deterioration under stressful conditions, such as combat" (Bryan & Regan, 1972). The performance standard used to pass a soldier on record fire is that of hitting 23 out of 40 targets. The MACS BRM system achieves overlearning by demanding a higher

standard, and making shooters who fail to meet the standard re-fire until they succeed. Thus in Levels 1 and 2, the standard is to hit 2 targets out of 3 at each range, which equates to 27 hits with 40 shots; failure to meet the standard at a range necessitates an immediate re-fire of three more targets at that range. In Level 3, the standard is to hit 3 out of 4 targets at each range; this equates to 30 hits with 40 shots, which is sharpshooter standard. In Levels 5 through 8, the standard is to hit 15 out of 20 targets in each firing position (supported and unsupported), which again equates to 30 hits with 40 shots, and failure to meet the standard requires an immediate re-fire of all 20 targets in that position.

Progression from Level 1 through Level 4 is determined by the mean ratings that the shooter receives at the end of each level, for steady position, aiming, trigger squeeze, and shot location. For Level 5 through Level 9, only shot location is considered.

For Levels 1 to 4, a shooter must achieve a mean rating of AVERAGE or better on all four measures before he is permitted to advance to the next level. A score of BELOW AVERAGE or POOR on any one measure indicates a failure to apply at least one of the fundamentals of marksmanship correctly at that level, and therefore the shooter is made to repeat the level. A mean rating of POOR on two measures will cause the shooter to be sent back one level.

A shooter who has progressed to Level 5 has demonstrated the ability to hold the rifle steady, aim correctly, squeeze the trigger without disturbing the lay of the weapon, and, not merely to hit a sufficient number of targets at each level, but to hit them close to center of mass. He has demonstrated this ability when firing in the supported and unsupported positions, and against timed targets in both positions. Therefore, from Level 5 onward the three individual diagnostic measures are dropped, and progress is determined solely by consideration of shot location. The rationale behind this is that, to achieve an adequate score on shot location, the shooter must be applying the fundamentals of marksmanship, and therefore the individual skills are still implicitly being tested. If, at the end of a level, the mean shot location is BELOW AVERAGE, then the shooter is made to repeat the level. If shot location is POOR, then the shooter is sent back one level.

One implication of these standards is that shooters may hit a sufficient number of targets to get through a level but will only pass the level if they have on average also hit close to their centers of mass. In this sense, the standards demanded for record fire in the MACS BRM program are higher than those demanded in actual record fire, where a hit is sufficient.

BRM Program Skill Tests

When new shooters begin on the MACS BRM program, they are automatically taken into hierarchically structured marksmanship skill tests that assess their abilities and determine appropriate starting levels. The process is described below, and is shown as a flow chart in Appendix C. The flow chart for programming is given in Appendix D.

As a first step in the testing process, the shooter is told to fire three rounds from the supported position to establish an initial shot group. These

first three rounds are of key importance to the system because they are used by the computer to perform an electronic equivalent of zeroing the rifle. The system assumes that shooters are aiming at the center of mass of each target to the best of their abilities. It then computes the central point of the three-round shot group, measures the distance between this central point and the actual center of the target, and uses this distance as a constant offset value, which is applied to all subsequent shots. In effect, it moves the shot group onto target electronically rather than by mechanical adjustment of the sights.

From the shooter's viewpoint, the sequence begins with information that states to aim at the center of mass targets, and illustrates what is meant by center of mass. The shooter fires one shot at each of three scaled 250-m, E-type targets. As soon as the three shots have been fired, a feedback screen is shown that gives ratings of steady position, aiming, and trigger squeeze, an assessment of the quality of the three-round shot group (POOR through EXCELLENT) and a close up of the target showing the three-round shot group. The rating of shot group is computed in the same way as that of shot location. The difference in name arises because, for the first three shots, the radial distance of each individual shot is calculated from the shot group center (which is not yet related to target center because the system is in the process of zeroing). Whereas subsequently, radial distances are directly related to the center of mass of targets, and shot location relative to the target can be reported.

As with actual rifle fire, the tighter the shot group the better the zero. The system is able to compute a usable zero offset from a very poor initial shot group, but a limit is set. For each target, a rectangular area is mathematically defined within which all three shots must hit for the shot group to be accepted. This rectangular area would equate to an area 46 cm wide and 24 cm high on a 25-m target. If the shot group is too large to fit within the rectangle, the shooter is told the shot group is invalid, and is invited to try again. If, on the second try, the group is still invalid, either the shooter is making some gross error (such as looking over the rear sight aperture rather than through it) or the light pen is out of alignment with the bore of the rifle and the system requires adjustment. This latter possibility is indicated on screen to cue the instructor, and a program can be accessed from the menu that will let the instructor test and, if necessary, reset the light pen alignment. This program is described subsequently.

Because the system is designed to teach novices, it will accept a very large shot group as valid (within the limits detailed above) and allow the shooter to proceed. The reason for this is that one cannot expect a novice to shoot a tight shot group until the fundamentals of marksmanship have been learned. MACS is designed to teach these fundamentals, and, to state the obvious, the shooter must be able to get into the system in order to learn. However, because the system is also designed to be used by experienced personnel in sustainment training, the shooter is given the option of refiring the first three shots until a tight three-round shot group is achieved. On MACS, a tight shot group is defined as one that is rated as GOOD and is equivalent to placing the three shots in a 3.7 cm circle at 25 m. Although any valid shot group will zero the system adequately for a novice, the experienced shooter may wish to continue to refire until a tight group is achieved. This is because the three-round shot group that the shooter finally

accepts is the one used to zero the system electronically for all future shots.

The shot group the shooter accepts is used also as an initial determinant of skill. If, for the measures of steady position, aiming, trigger squeeze, and shot group, shooters obtain a minimum of two ratings of EXCELLENT and two ratings of GOOD (irrespective of order), they are judged to be competent in firing at non-timed targets in the supported position. Those who do not meet this standard are routed immediately to Level 1 (Introduction to Supported Position). For shooters who meet the standard, a second three-round test is given, using the same targets but engaged from the unsupported position. The same criteria are applied. Those who do not meet the standard are directly routed to Level 2 (Introduction to Unsupported Fire). Shooters who pass the second test take a third test that comprises three timed targets at different ranges (100, 250, and 300 m), the targets to be engaged from the supported position. Failure to meet the standard on the third test takes a shooter to Level 3 (Timed Targets in the Supported Position). Shooters who meet the standard are given a fourth and final test, which is identical to the third, except that it is fired from the unsupported position. Failure to meet the standard in this test routes the shooter to Level 4 (Timed Targets in the Unsupported Position), and success takes the shooter to Level 5 (Practice Record Fire).

The four tests are hierarchically structured to select the very able shooters. The poor shooter and the novice never know that they have been tested or that the tests exist; they simply establish a shot group and go straight to Level 1. The standards demanded in the tests are deliberately set at a high level, so that only those who have no need of additional training or practice in the fundamentals of marksmanship can move straight to practice record fire. Although the system will automatically direct a shooter to a starting level that the system's internal logic deems appropriate, the instructor can override the system. If the instructor feels that a level is inappropriate, the menu can be accessed, and the shooter moved to a different level.

BRM Program Menu and Options

The program contains a menu that allows a number of additional programs and special features to be called into use. These are described below.

Light Pen Mount Alignment Program

The light pen is mounted to the barrel of the M16 demilitarized rifle by a mounting bracket. This bracket holds the light pen securely and in alignment with the bore of the weapon. Accident or rough handling can disturb the alignment, and therefore a program is provided to allow the instructor to check the alignment and realign if necessary. The alignment program provides an on-screen aiming point and a target area. The point at which the light pen is reading is shown by a black dot on the screen. If the black dot is in the target area when the sights are placed on the aiming point, and if the black dot tracks smoothly across the screen as the weapon is moved, then the light pen is correctly aligned. If the light pen is incorrectly aligned then the mounting screws must be loosened and the light pen position adjusted. The

procedures for this may be found in the Trainer's Guide (Purvis & Wiley, 1989).

Sight Alignment, Aiming, and Grouping Program

The program is designed to teach three basic concepts; these are the correct alignment of the front and rear sights, the correct placement of the front sight post on the target, and the meaning of a tight shot group. Programming flow charts for this program may be found in Appendix E. The program is divided into four parts.

The first part provides a demonstration of the correct alignment of front and rear sights, which is followed by a self-paced test in which a series of sight alignments are shown on the screen and the soldier must determine whether alignment is correct. The soldier responds by pulling the trigger on the MACS rifle when the appropriate response is highlighted on the screen. Feedback is given after each decision. The feedback acknowledges correct responses and, when responses are incorrect, tells the soldier why the answer was wrong. Soldiers must give three consecutive correct answers to move on to the next part of the program.

The second part of the program provides a demonstration of correctly aligned sights moving onto a scaled 250-m, E-type target. The demonstration is supported by on-screen text and is iterative, continuing until the soldier understands and is ready to proceed. The demonstration is followed by a self-paced test, which is structured exactly like that for sight alignment.

The third part is a test, in which a series of randomly generated sight pictures are shown. One in three of these sight pictures is correct; the remainder have poor sight alignment and/or incorrect placement of the front sight post on the target. As with the previous two tests, the soldier indicates correct or incorrect using the trigger as a response button. Feedback is given after each decision, and the shooter must give three consecutive correct answers to complete the test.

Although the primary purpose of the program is to teach concepts, because precision of sight placement is required in marksmanship, fine judgments are demanded of the soldier in the tests. The soldier is required to detect errors in sight placement that range between 1 and 3 pixels in the X axis and 1 and 2 pixels in the Y axis. At 3 m, the height of a pixel (Y axis) subtends an angle at the eye of 1.1 minutes of arc, and the width of a pixel (X axis) subtends 0.84 minutes of arc. Of the two, the Y axis displacement is the more difficult to resolve because, on occasions, the soldier must hold an image of the target in memory when making a judgment. This is because the image of the front sight post may obscure the lower part of the target. In the X axis, the soldier must discern the degree of lateral displacement and can use the sides of the target and the sides of the sight as referents. The 0.84 minutes of arc minimum displacement is well within human capabilities; indeed, Berry, Riggs, & Duncan (1950) have shown that discriminations of lateral displacement (vernier acuity) as small as 6 seconds of arc are possible even with low background luminance levels.

The fourth part of the program is designed to help the novice understand the difference between a tight shot group and a large shot group. It does

this by showing demonstrations of three-round shot groups hitting the image of a 25-m zeroing target. The referent taught is the 4-cm circle in the center of the target. Once the soldier has seen the demonstration, a self-paced test is given in which the soldier is asked to judge whether or not a series of shot groups are tight. Feedback is given after each decision. The feedback either acknowledges a correct response or, in the case of an incorrect response, demonstrates whether the three-round shot group would fit inside the 4-cm circle. The soldier must answer three consecutive questions correctly to complete the program.

The MACS BRM program has a number of optional features that an instructor can elect to use with some levels of the program. These are given on a menu that the instructor can access at the keyboard and are briefly described below.

Wind Speed

The program allows an instructor to set wind speed at 0, 10, or 20 mph, and wind direction relative to the firing range (across the range, oblique to the range, or in line with the range). This option may be selected for any and all levels of fire. To help the instructor teach soldiers the correct sight placement, a teaching screen appears at the start of the shooting sequence, which shows the correct sight placement on targets at 50, 150, and 300 m for the direction and speed of wind selected.

Call Your Shot

This option applies only to Levels 1 and 2. For each shot, it builds in a 5-s time delay (with on-screen counter) before feedback and bullet strike are shown. This allows the shooter time to announce where they believe the bullet strike will be.

Targets at 250 M

This option applies to Level 1 only. It allows the instructor to set all 18 targets to 250 m, so that the shooter can practice at a single range. It is intended for use with novice shooters who are experiencing difficulty at Level 1, and it parallels the ability instructors have in live fire of moving a novice to a 25-m range for practice. The 25-m target is a scaled-down, 250-m target, as is the target on the MACS screen, so that the two equate.

Discussion

The development of the MACS BRM program was evolutionary rather than entirely planned. It began as a diagnostic tool to help instructors determine what a shooter was doing wrong. This early program resembled Level 1 of the present BRM program. Subsequently, the diagnostic program was transformed into a teaching program. The transformation process was gradual, and as a result the system received considerable testing during development. In the process, less advanced versions than that described in this paper were demonstrated to be effective in improving rifle marksmanship (Evans, 1988).

The transformation from diagnostic tool to training device obviously necessitated many changes. For example, a new measure, aiming, was introduced

because aiming is one of the four fundamentals of marksmanship taught by the Army. New levels were added to take the soldier through to record fire standard, and the standards themselves were tightened so that they paralleled those demanded of soldiers on actual ranges. Because these changes happened sequentially rather than as a planned single modification, the reader may have formulated some questions on developmental methodology. For example, it is reasonable to ask why, given the new training role, the criteria for rating performance are still based on a modified version of trainees performance, and why no new data from trained soldiers have been collected. The answer is twofold. First, time constraints did not permit additional experimentation. Second, and from a purely practical viewpoint, the present system works, and there is no reason to believe that the quality of teaching the system provides will be significantly improved if additional research is done.

Summary and Recommendations

As has been noted, earlier versions of the MACS BRM program have been demonstrated to improve soldier performance in marksmanship. The present system is an enhanced version that reduces the load on the instructor, has greater flexibility in that the experienced user can now establish a shot group before starting, and is more in accord with Army standards for marksmanship. However, it has not been formally validated. Indications from both in-house SMEs and U.S. Army Marksmanship Unit personnel (n=6) are that the feedback the system provides is both realistic and appropriate. From this we may conclude that the current version has face validity. If there is a need to prove to the Army that soldiers trained, in part on MACS BRM will learn more rapidly, or if there is a need to demonstrate the degree of improvement that may be gained by using the system, then it is recommended that a new system validation be undertaken.

References

- Berry, R. N., Riggs, L. A., & Duncan, C. P. (1950). The relation of vernier and depth discrimination to field brightness. Journal of Experimental Psychology, 40, 349.
- Bilodeau, E. A., & Bilodeau, I. McD. (1958). Variable frequency of knowledge of results and the learning of a simple skill. Journal of Experimental Psychology, 55, 379-383.
- Bilodeau, I. McD. (1966). Information feedback. In E. A. Bilodeau, (Ed.), Acquisition of skill (pp. 255-296). New York: Academic Press.
- Bryan, G. L. & Regan, J. J. (1972). Training system design. In H. P. Van Cott, & R. G. Kincade, (Eds.) Human engineering guide to equipment design (pp. 633-666). Washington: U.S. Government Printing Office.
- Department of the Army (1988). Final draft: M16A1 and M16A2 rifle marksmanship. Washington, DC: Author.
- Evans, K. L. (1988). Development and evaluation of the multipurpose arcade combat simulator (MACS): A research summary (ARI Research Report 1488). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (DTIC No. AD-B130 099)
- Hunt, J. P., Broom, J. M., Greene, W. H., Crawford, J. W., Martere, R. F., & Parish, J. R. (1987). Multipurpose arcade combat simulator (MACS): Year two report (ARI Research Note 87-34). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (DTIC No. AD-A 184 179)
- Lavery, J. J. (1962). Retention of simple motor skills as a function of type of knowledge of results. Canadian Journal of Psychology, 16, 300-311.
- Osborne, A. D., & Smith, S. (1985). Unit rifle marksmanship training guide (ARI Research Product 85-12). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (NTIS No. AD-B 105 422)
- Purvis, J. W. & Wiley, E. W. (1989). Trainer's guide: Multipurpose arcade combat simulator (M16 rifle) (ARI Research Product). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.
- Smith, K. U., & Smith, M. F. (1966). Cybernetic principles of learning and educational design. New York: Holt, Rinehart & Winston.
- Stammers, R., & Patrick, J. (1975). The psychology of training. London: Methuen.
- U.S. Army Infantry School. (1984). Unit rifle marksmanship training guide (Field Circular No. 23-11). Fort Benning, GA: Author.

APPENDIX A

Summary Description of Levels

Level 1. Introduction to Supported Position

Summary description

- No time limit
- Supported position
- Single-target presentations
- Eighteen targets presented, three targets at each of six ranges
- Targets engaged in order of range: 50, 100, 150, 200, 250, and 300 m

Feedback

- Words HIT or MISS appear on screen for each shot
- Cross appears on screen to show bullet strike
- Diagnostics and replay are shown after each shot
- Screen shows three rounds on single target after each group of three shots
- Summary screen at end of level shows average diagnostic scores

Standards

- Two hits out of three shots at each range within level. Failure to meet standard at a given range results in immediate refire of 3 more targets at that range. Refires continue until standard is met
- Refire of level is required if any score on summary screen is BELOW AVERAGE or POOR

Level 2. Introduction to Unsupported Position

Identical to Level 1, with these exceptions:

- It is fired in the unsupported position
 - Shooter is regressed a level if any 2 scores on summary screen are POOR
-

Level 3. Timed Targets in Supported Position

Summary description

- Time limit approximately one-and-one-third times that for record fire
- Supported position
- Single target presentations
- Twenty-four targets in random sequence (four presentations per range)

Feedback

- Cross appears on screen to show bullet strike
- For a hit, target disappears immediately after bullet strike is shown
- Diagnostics and replay are shown after bad shots only. Criteria for bad shot is a POOR for any score or a BELOW AVERAGE for shot location
- Audible tone when target exposure time limit has expired
- Summary screen at end of level showing average diagnostic scores
- Summary screens showing four shots at each range on single targets

Standards

- Three hits out of four shots at each range within level. For each range at which this standard is not met, a refire of four targets at each of those ranges is required. Refires continue until standard is met
- Refire of level is required if any score on summary screen is BELOW AVERAGE or POOR
- Shooter is regressed a level if any two scores on summary screen are POOR

Level 4. Timed Targets in Unsupported Position

Identical to Level 3, with these exceptions:

- It is fired in the unsupported position
 - Standard is relaxed. Three hits out of four shots at 50, 100, 150, and 200 m, and two hits out of four shots at 250 m and 300 m
-

Level 5. Practice Record Fire I

Summary description

- Time limit same as for record fire
- Supported and unsupported positions
- Single or double presentations
- Forty targets in random sequence, 20 fired supported and 20 unsupported.

Feedback

- Cross appears on screen to show bullet strike (hit and miss)
- For a hit, target disappears after bullet strike is shown
- Audible tone when target exposure time limit has expired
- OUT OF AMMO appears on screen when 20 shots have been fired
- Interim summary of shot location (hits, misses, and no fires) given at end of each position and final summary at end of course of fire
- Summary screens showing shots at each range on a single target at end of supported position and at end of unsupported position
- Performance graded as Expert, Sharpshooter, Marksman, Unqualified

Standards

- Fifteen hits out of 20 shots in both supported and unsupported positions. Refire of position if standard not met
- On double target exposures, a penalty is recorded if further target is engaged first
- Regress one level for average shot location score of POOR. Stay at same level for mean shot location score of BELOW AVERAGE. Otherwise pass

Level 6. Practice Record Fire II

Identical to Level 5, with the exception that the cross showing bullet strike appears only after misses. Target disappears when hit.

Level 7. Record Fire

Summary description

- Time limit same as for record fire
- Supported and unsupported positions
- Single or double presentations
- Forty targets in random sequence, 20 fired supported and 20 unsupported

Feedback

- Targets disappear when hit
- OUT OF AMMO appears on screen when 20 shots have been fired
- Audible tone when target exposure time limit has expired
- Interim summary of shot location (hits, misses, and no fires) given at end of each position and final summary at end of course of fire
- Summary screens showing shots at each range on a single target at end of supported position and at end of unsupported position
- Performance graded as Expert, Sharpshooter, Marksman, Unqualified
- Cross appears on screens to show bullet strike for misses, whenever soldier has to refire level

Standards

- Fifteen hits out of 20 shots in both supported and unsupported positions. Refire of position if standard not met
- On double target exposures, a penalty is recorded if further target is engaged first
- Regress one level for average shot location score of POOR. Stay at same level for mean shot location score of BELOW AVERAGE. Otherwise pass

Level 8. Rapid Record Fire I

Identical with Level 7, except that the exposure times of targets are two-thirds of those used in record fire.

Level 9. Combat Fire

Summary description

- Time limits variable, dependent on number of targets presented
- Supported and unsupported positions
- Single, double, and multiple presentations
- Eighty targets in two attack/retreat scenarios each of 40 targets.
First scenario is fired supported and second unsupported

Feedback

- Targets disappear when hit
- OUT OF AMMO appears on screen when 40 shots have been fired
- Summary of shot location (hits, misses, and no fires) given at end of supported position and at end of unsupported position
- Summary screens showing shots at each range on a single target at end of supported position and at end of unsupported position
- Performance graded as Expert, Sharpshooter, Marksman, Unqualified
- Cross appears on screens to show bullet strike for misses, whenever soldier has to refire level

Standard

- Twenty-three hits out of 40 shots in both supported and unsupported positions. Refire of position if standard not met
-

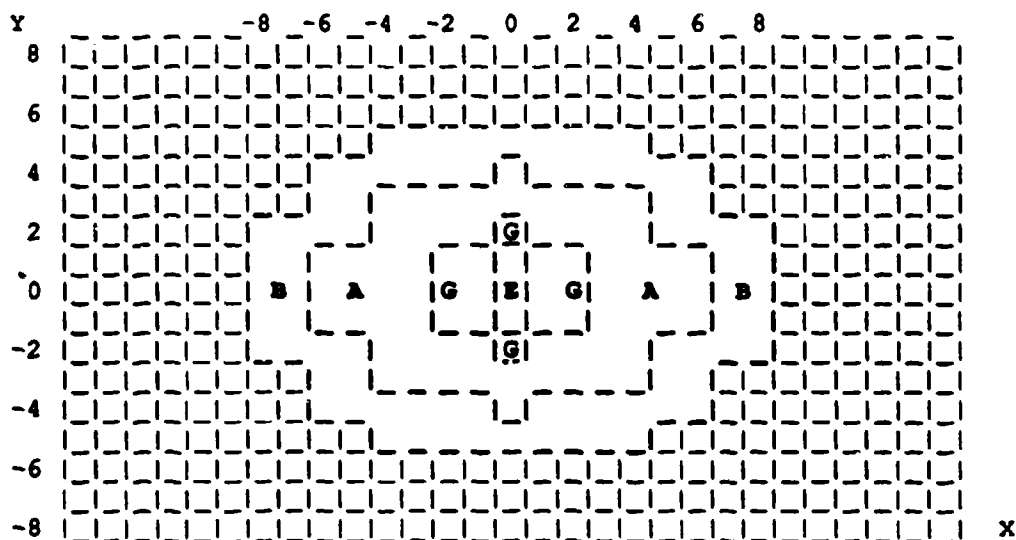
APPENDIX B

Criteria Target Areas for Aiming and Shot Location

The target area that is mathematically defined for the aiming and shot location scores differs from the effective target area that was shown in the main text. For comparison purposes, both are shown in Figure B-1. The reason that the effective target area is different is as follows. The computer stores the X and Y coordinates of a pixel location each as a single byte. One byte can hold the record of any value between 0 and 255. The screen is 200 pixels high, and therefore each pixel location in the Y axis can have a separate 1 byte address. However, this is not possible in the X axis because the screen is 320 pixels wide. Because only one byte is allocated to describe the X axis location, the computer divides the number of the pixel by two before storing it. Thus, pixel number 300 is stored as pixel number 150, and when the pixel number is retrieved from memory, its stored value is doubled to recreate its original value. Unfortunately, when a number is halved and stored, it is stored as an integer so that any fractional values are lost. Thus, pixel number 301 is not stored as 150.5, but as 150; when it is retrieved, it is doubled and becomes 300. Therefore, if the light pen is focused on an odd-numbered pixel in the X axis, it is reported by the computer as the value of the pixel immediately to its left.

This system peculiarity has two implications: First, targets must be (and are) located with their centers of mass on even-numbered pixels in the X axis (were it otherwise, a score of excellent would be impossible to obtain). Second, the target areas are distorted compared with those that were mathematically defined. In defining target areas that scale to actual areas on the 25-m zeroing target, this distortion was taken into account.

Mathematically Defined Target Area (Supported Position)



Effective Target Area (Supported Position)

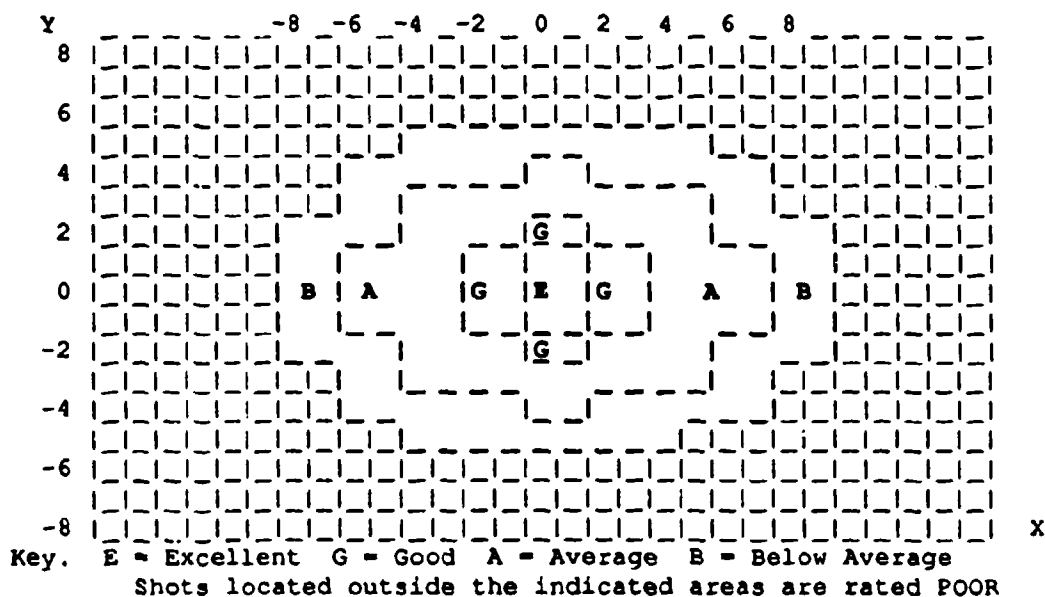
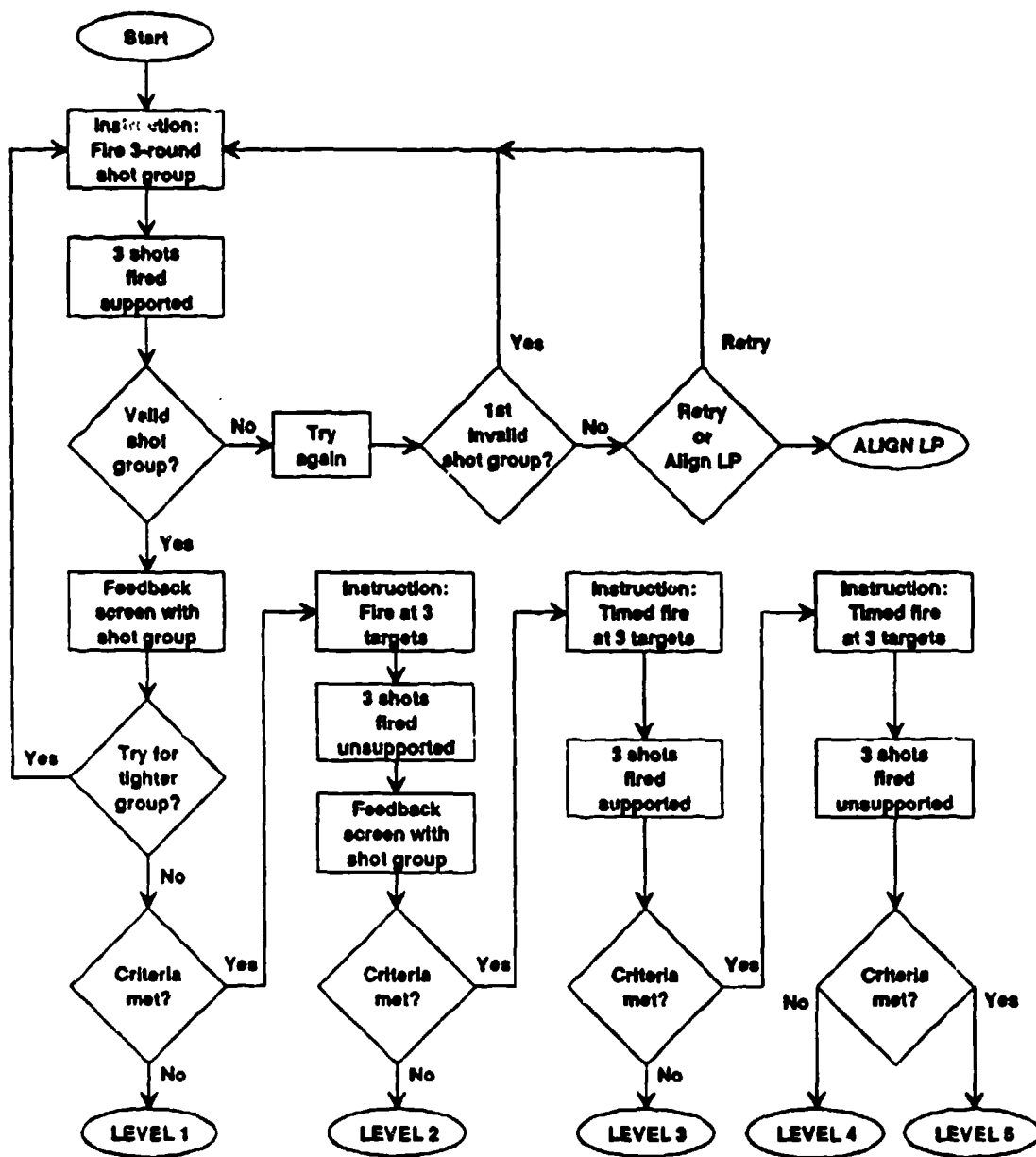


Figure B-1. Comparison between mathematically defined target area, and the effective target area.'

'The effective target area is adjusted for the fact that the computer reports readings from an odd-numbered pixel in the X axis as having the same value as the pixel immediately to its left. Actual pixels are longer in the Y axis than in the X axis (approximate ratio is 1.33:1); therefore, the on-screen target area is more circular in shape than is shown.

APPENDIX C

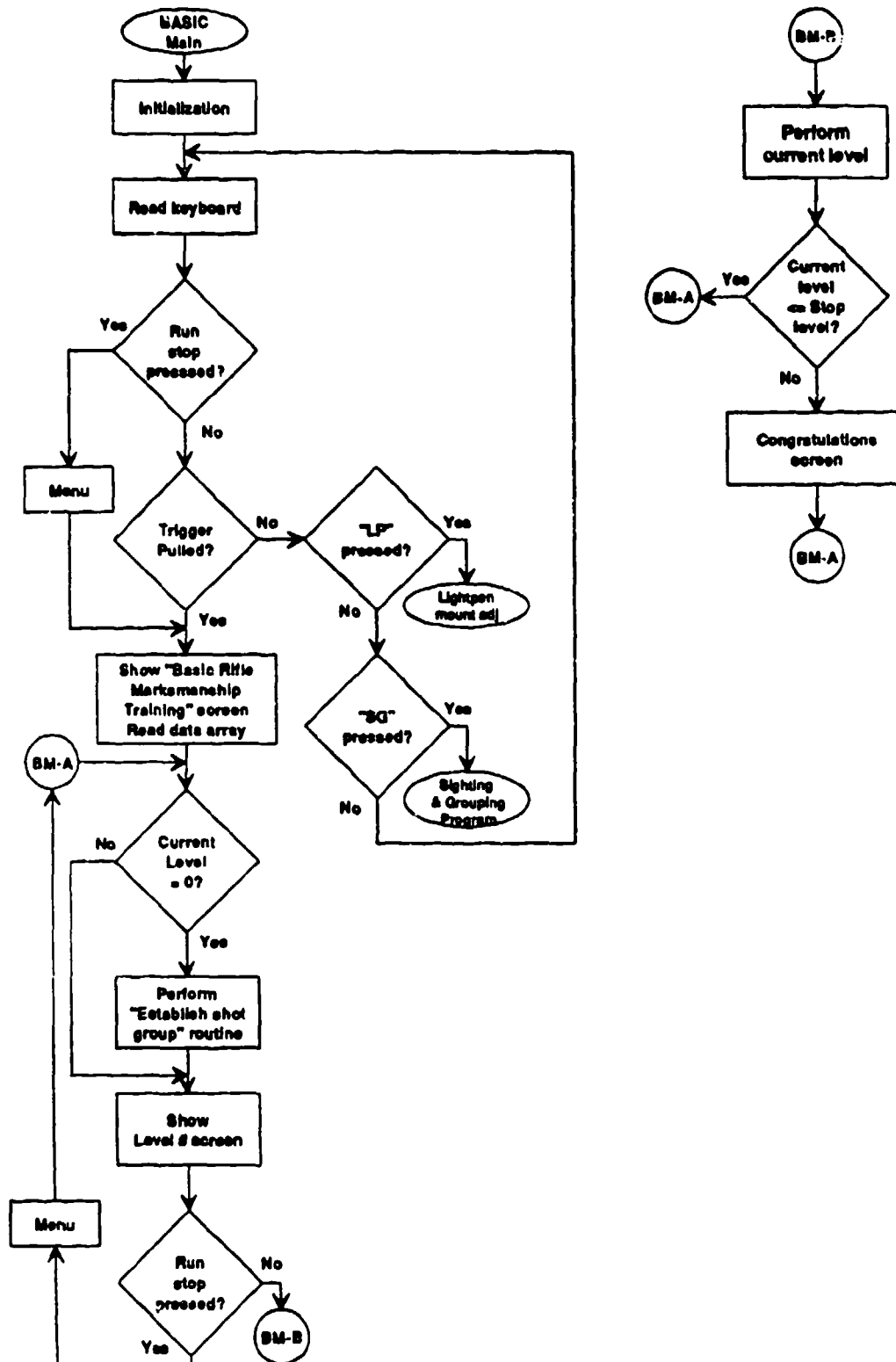
Users' Flow Chart for the Marksmanship Skill Tests¹

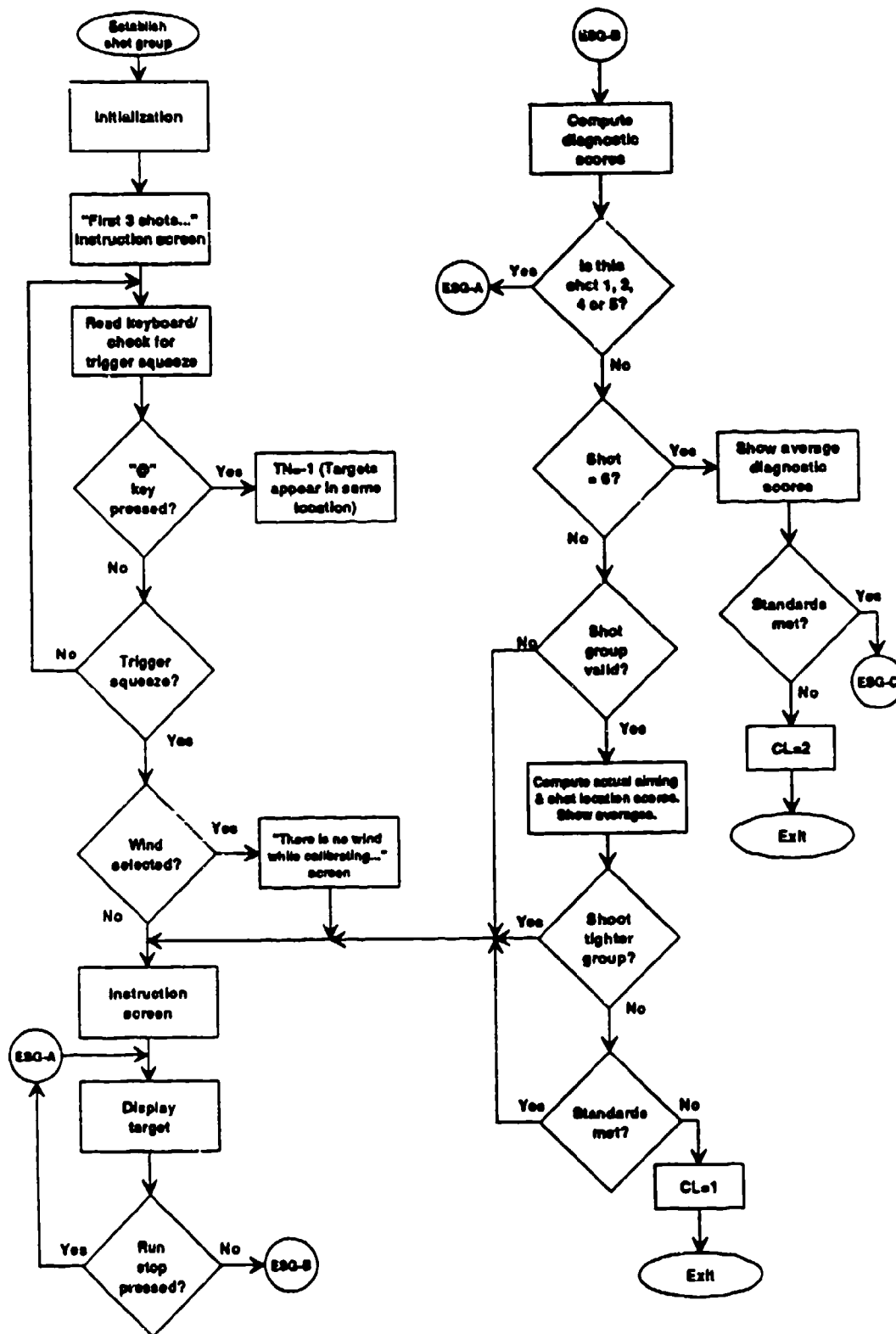


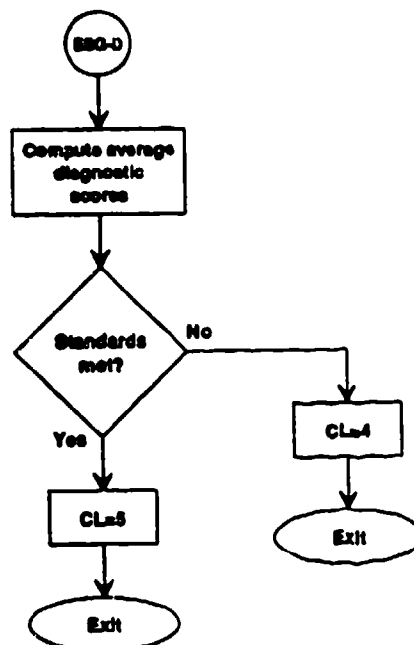
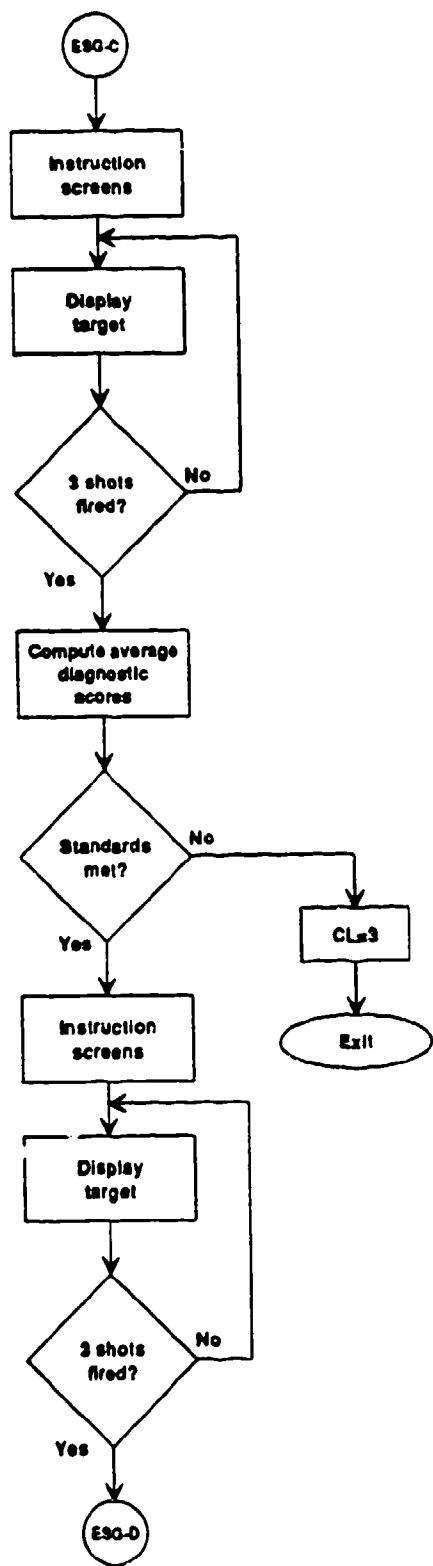
¹Initial Skill Test Criteria - For the measures of shot location, steady position, aiming, and trigger squeeze, the firer must earn two ratings of GOOD and two ratings of EXCELLENT to pass each test. The firer does not see ratings after the second test.

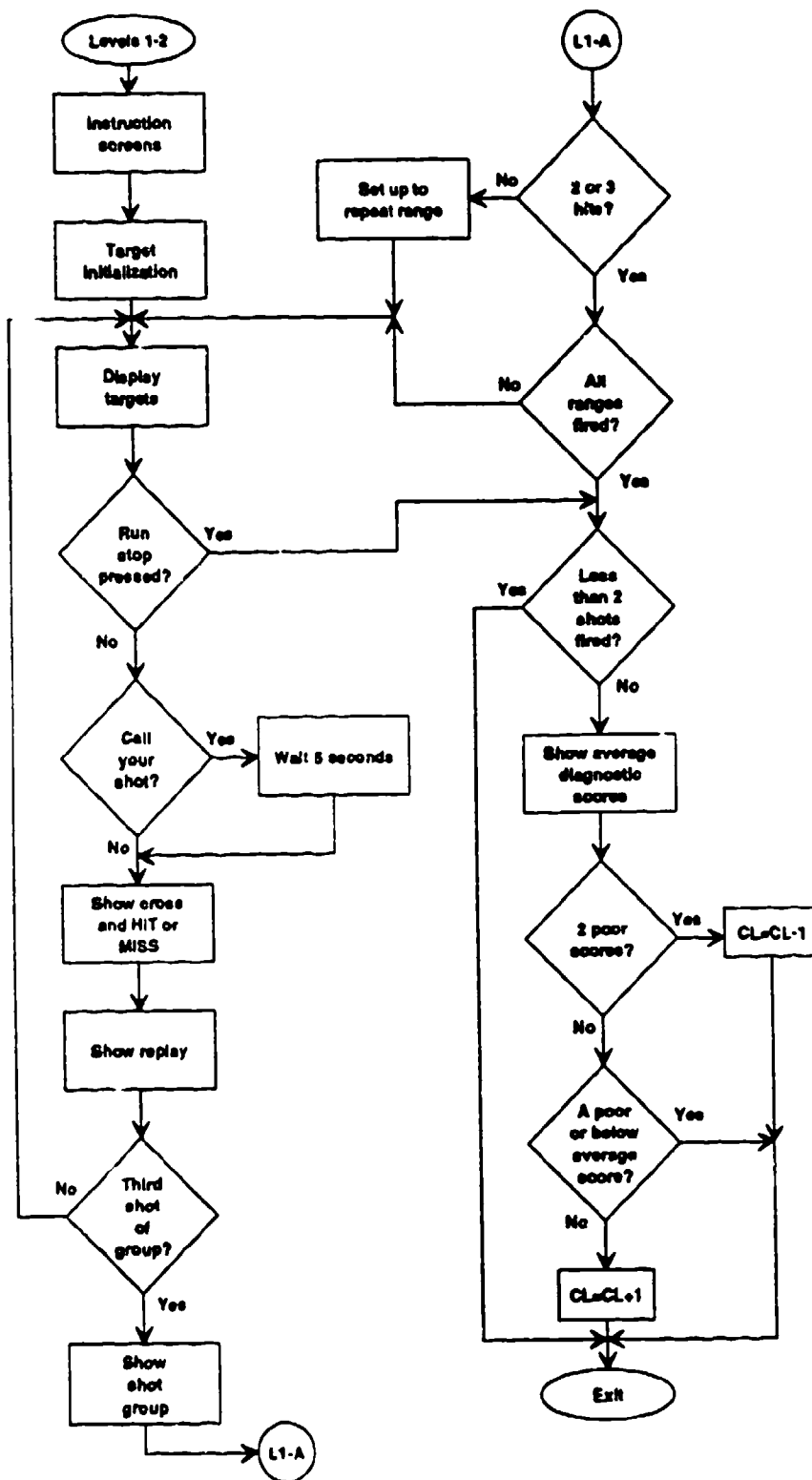
APPENDIX D

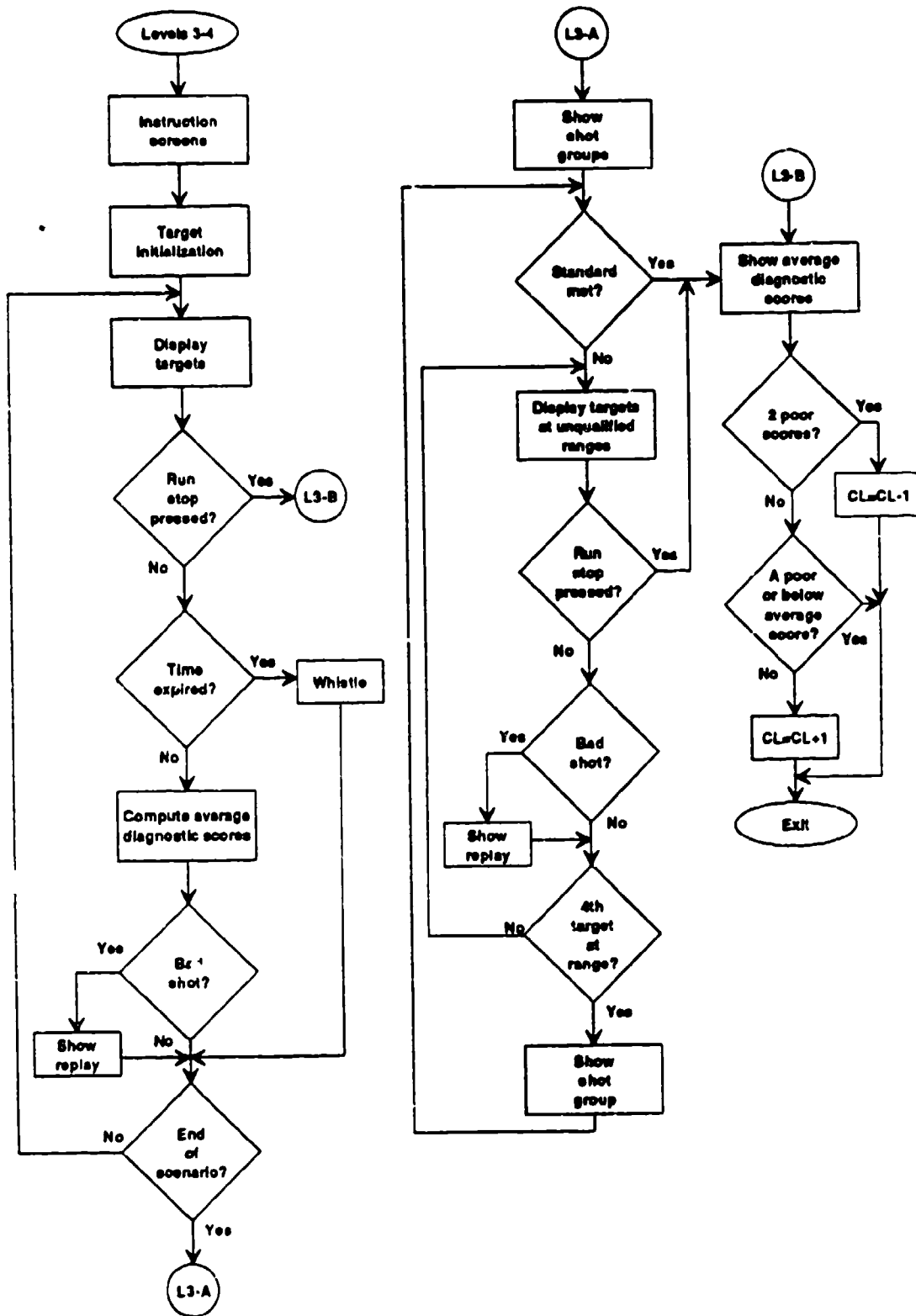
Programming Flow Chart for the BRM Program

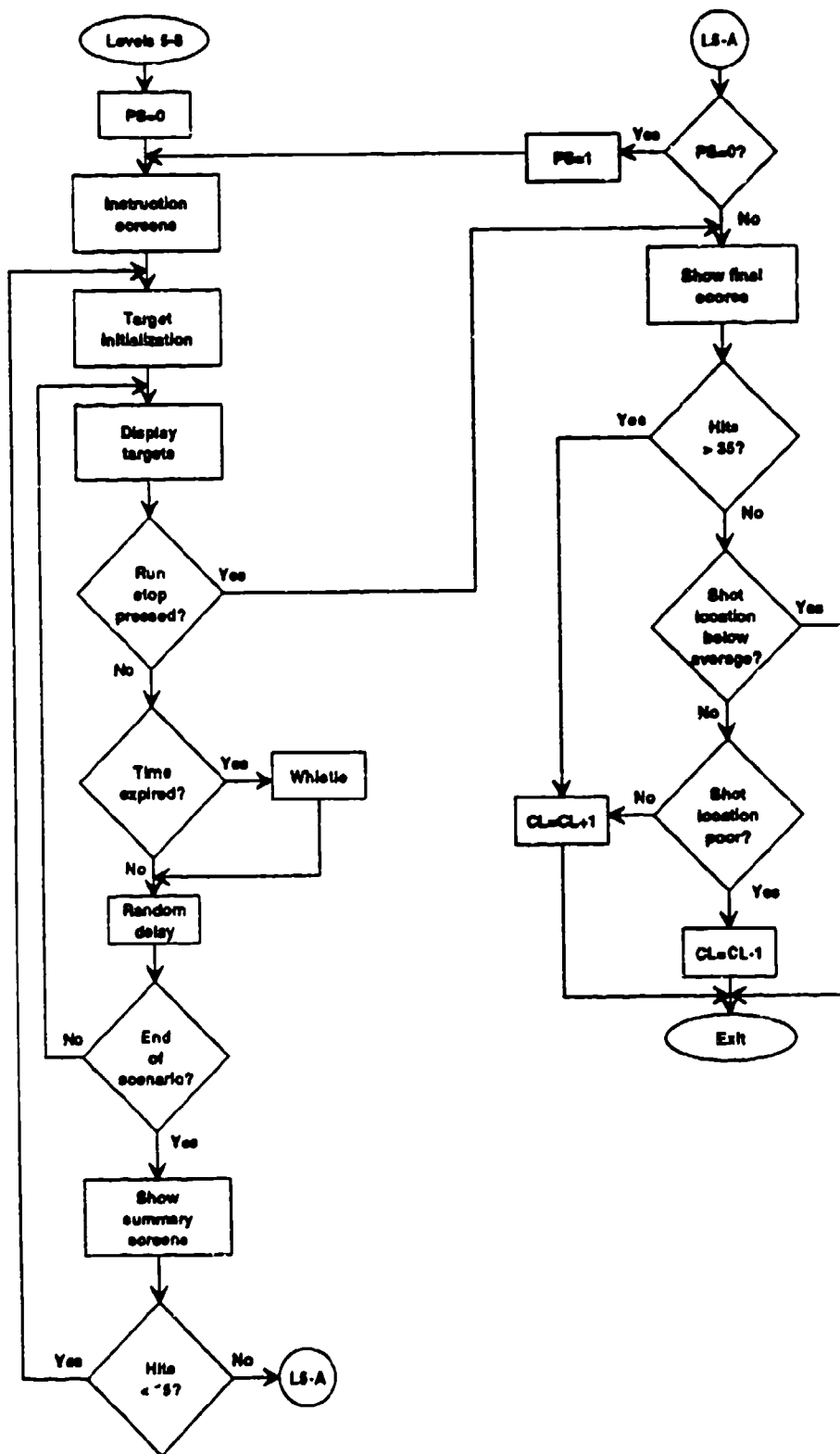


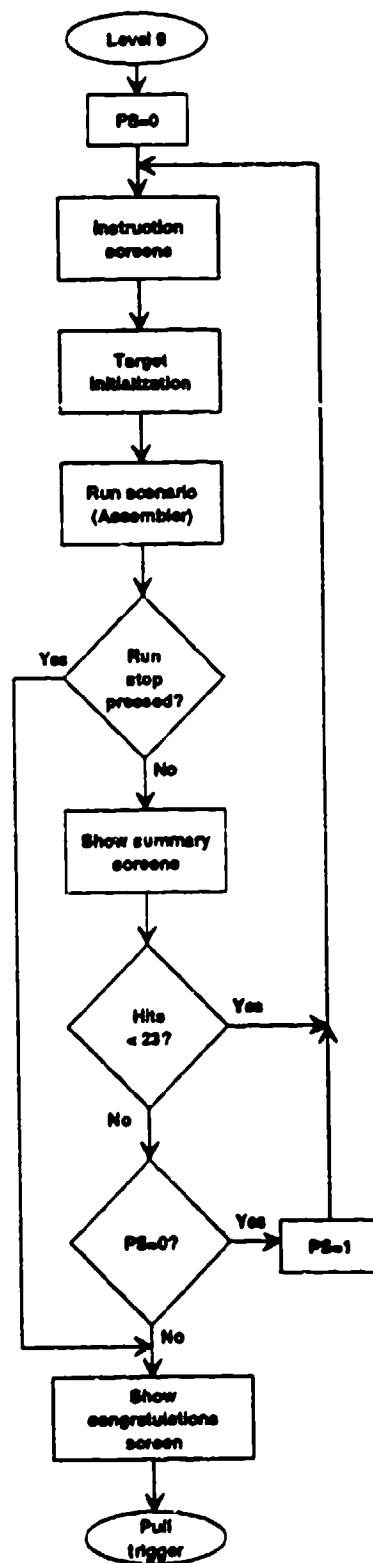


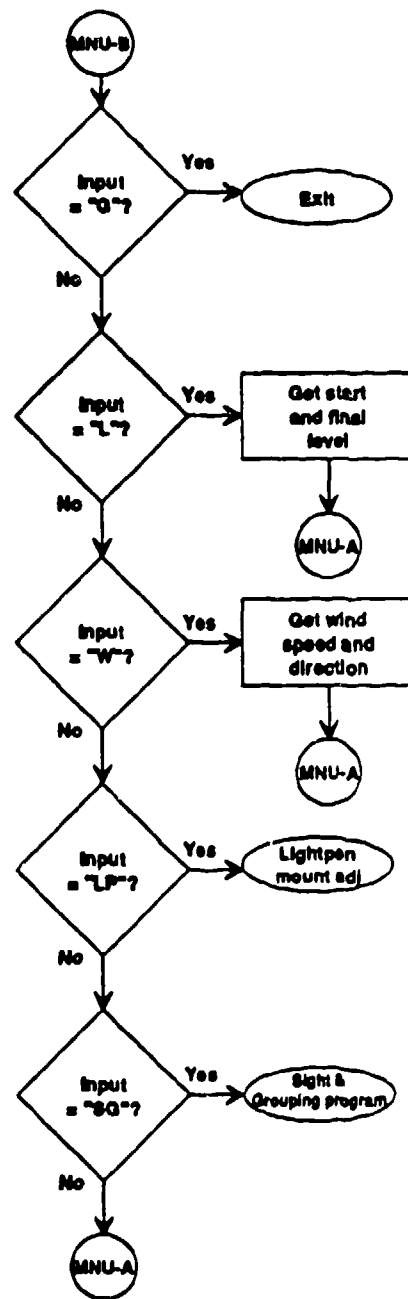
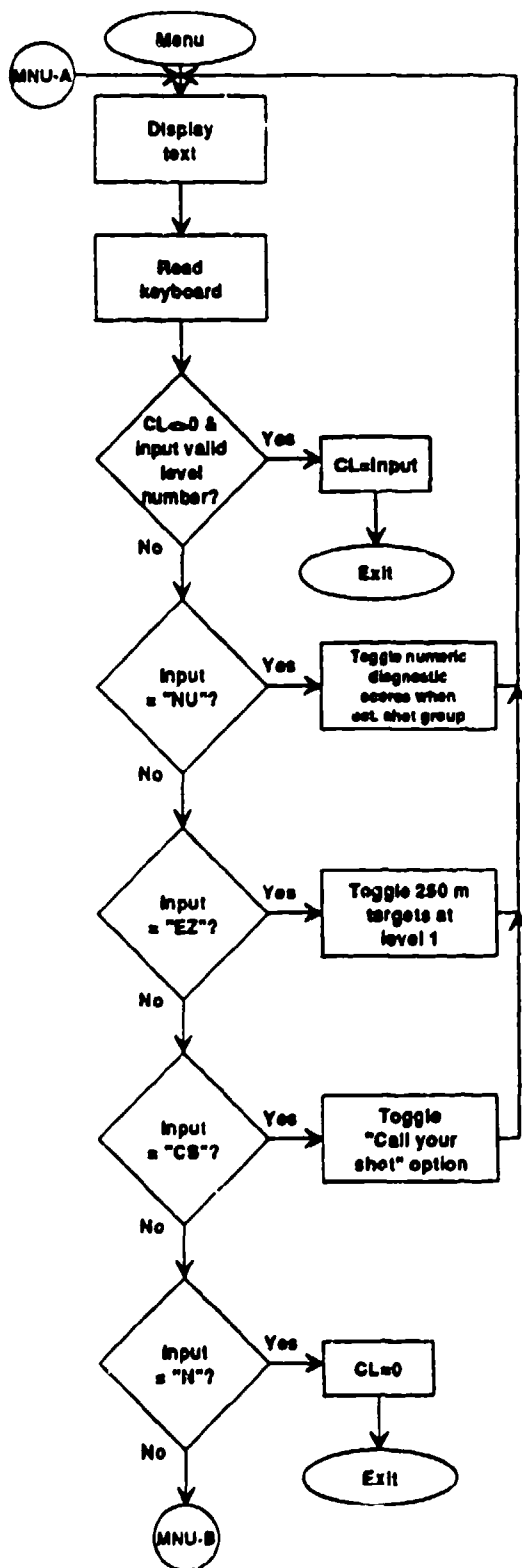


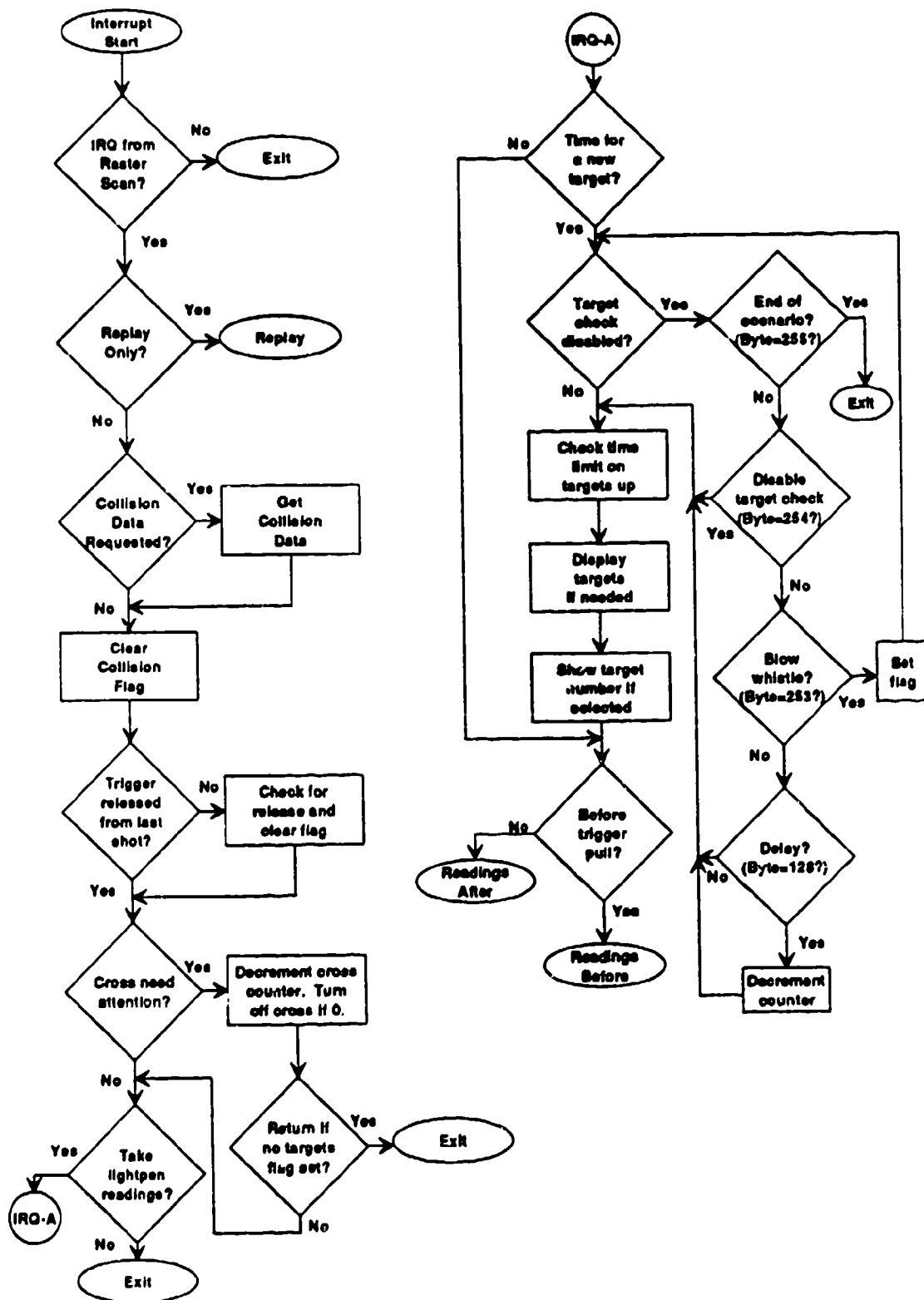


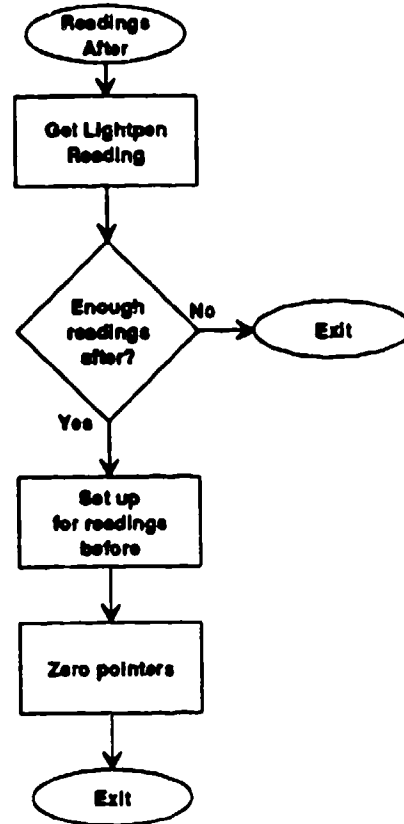
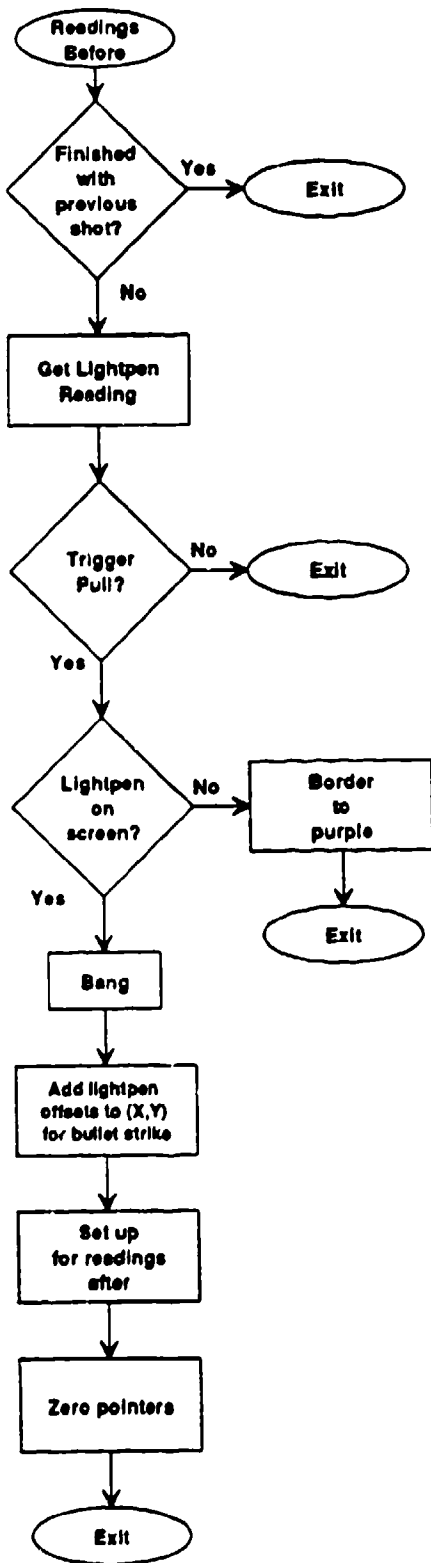


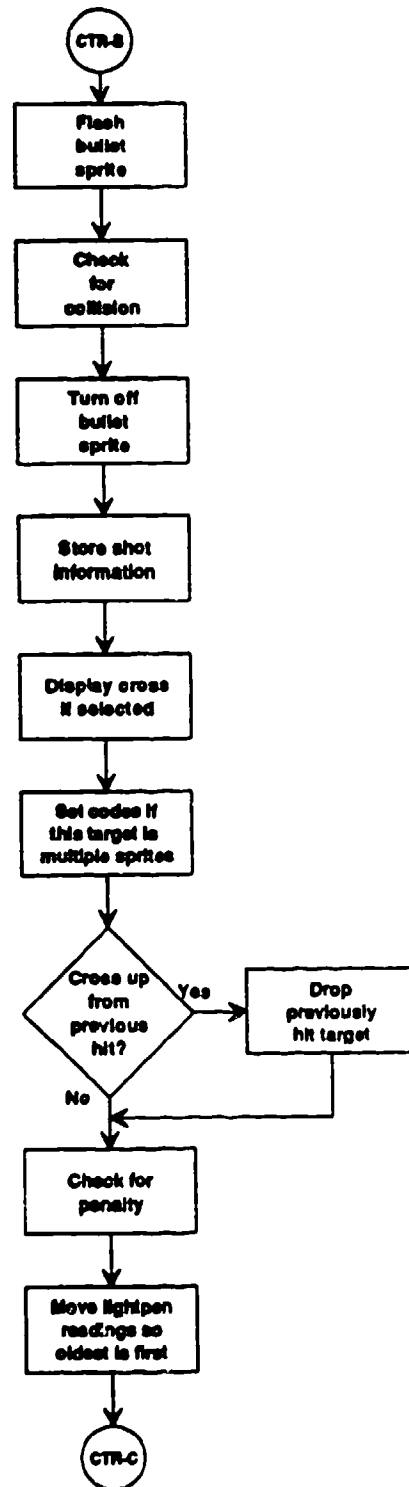
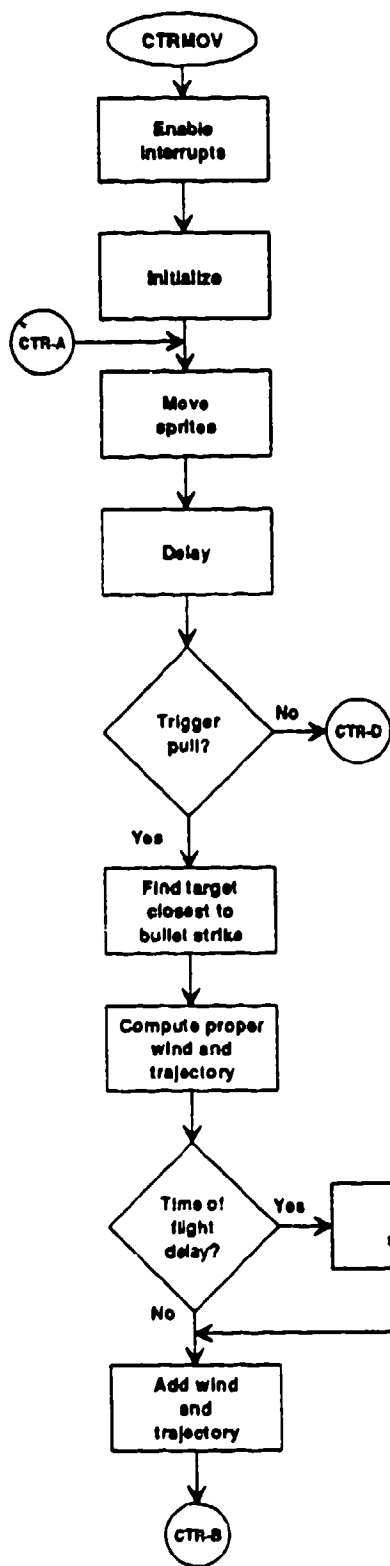


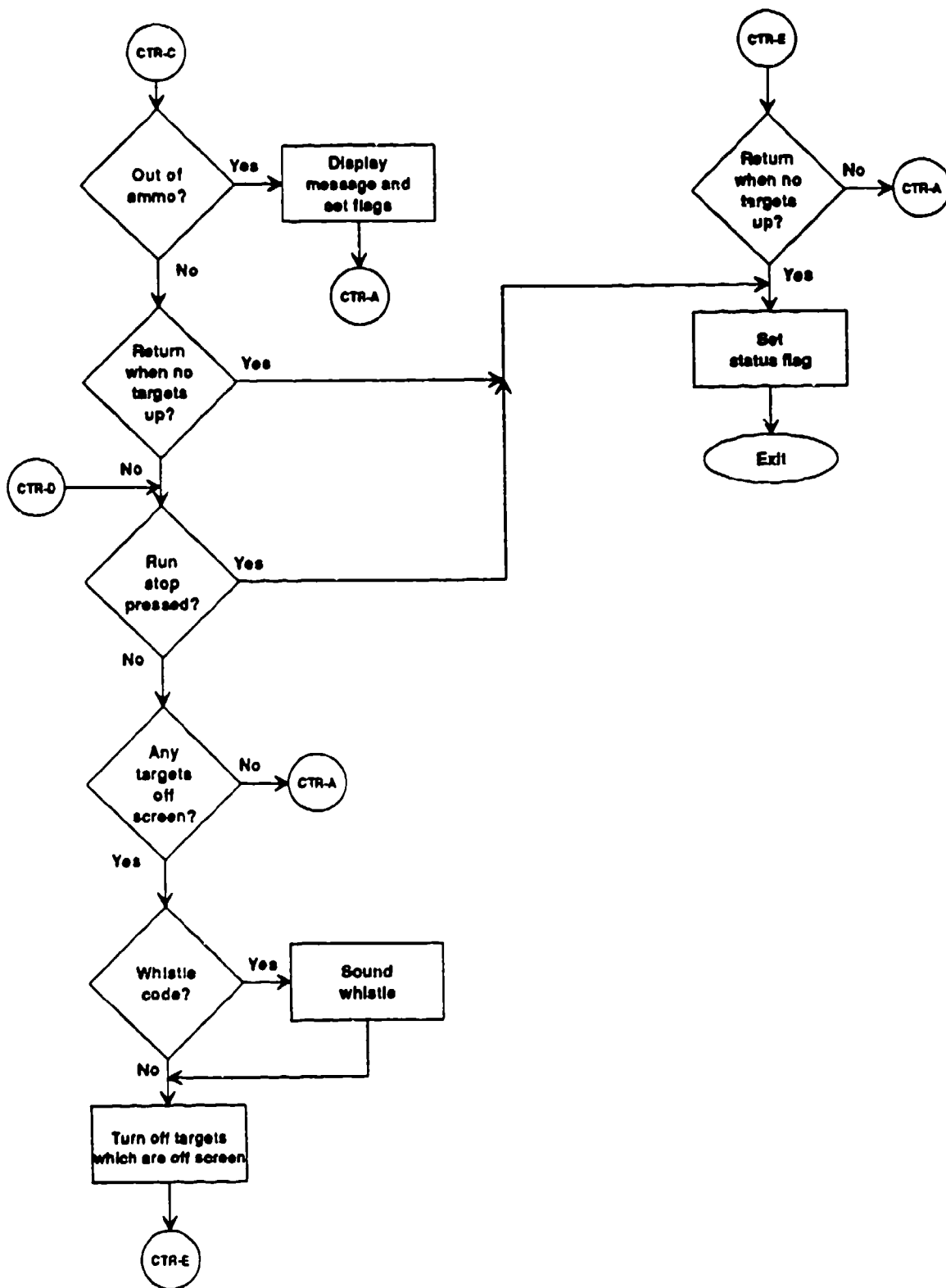


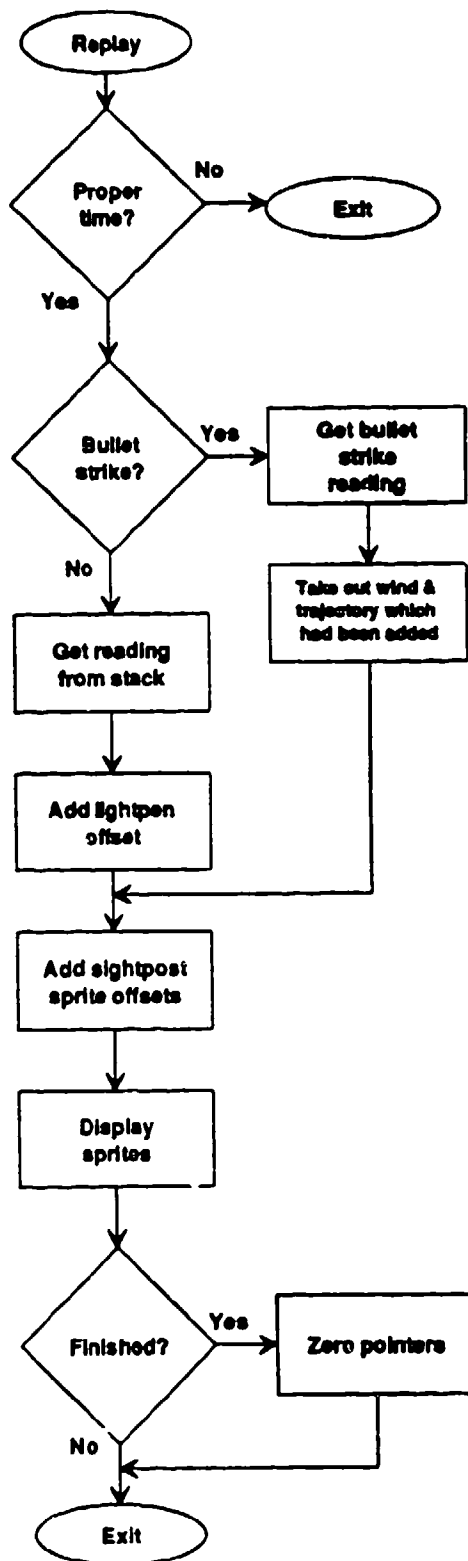






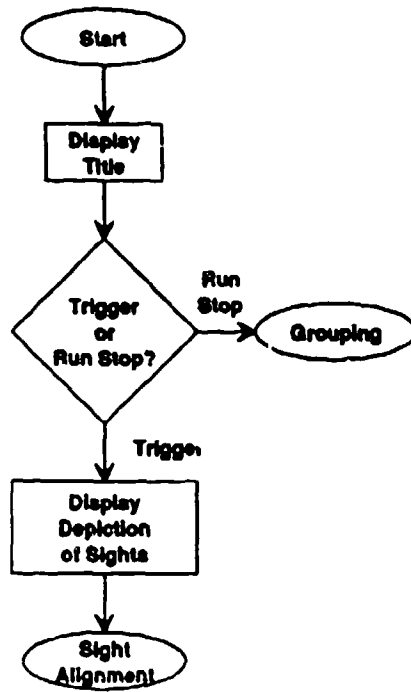


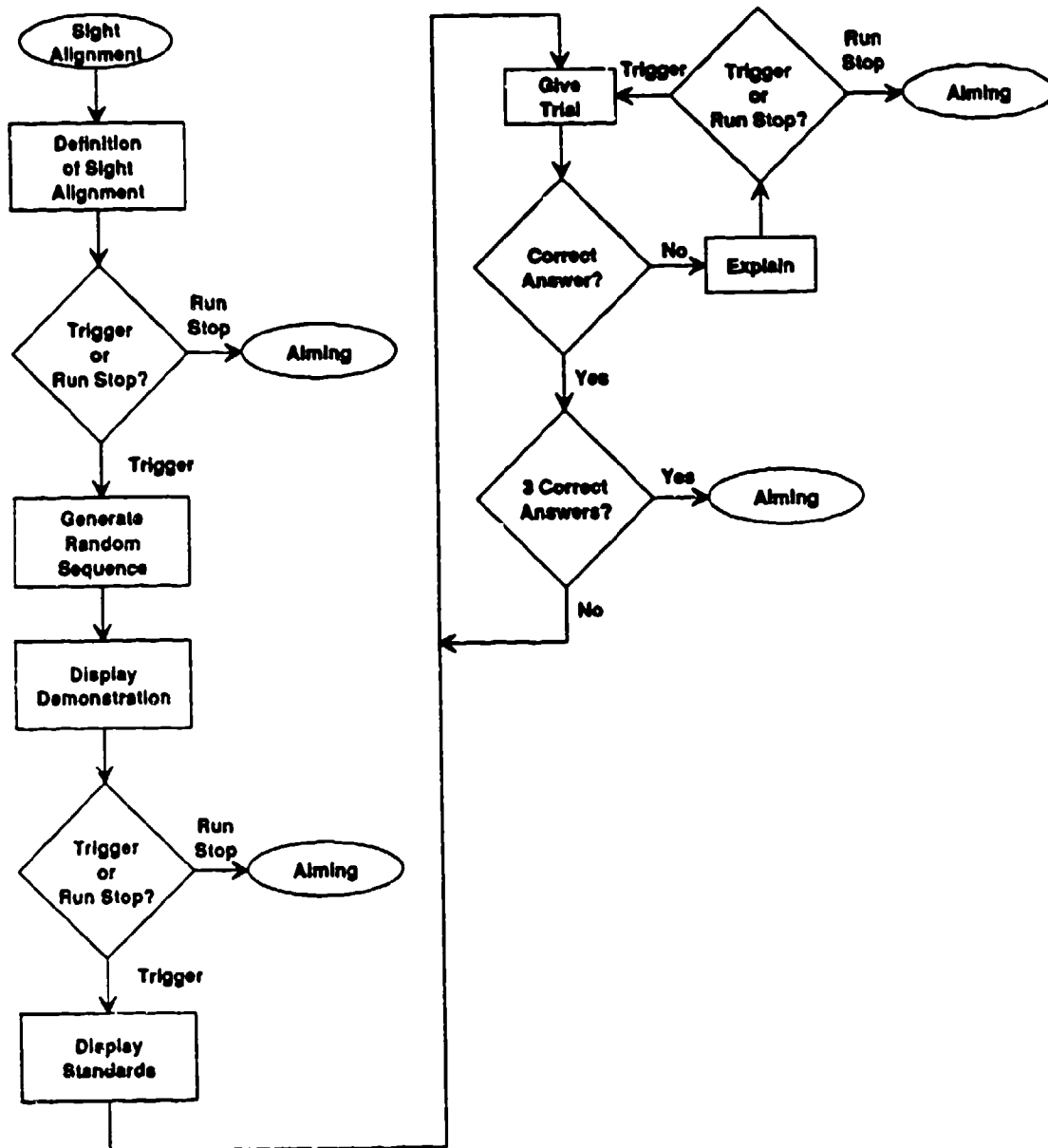


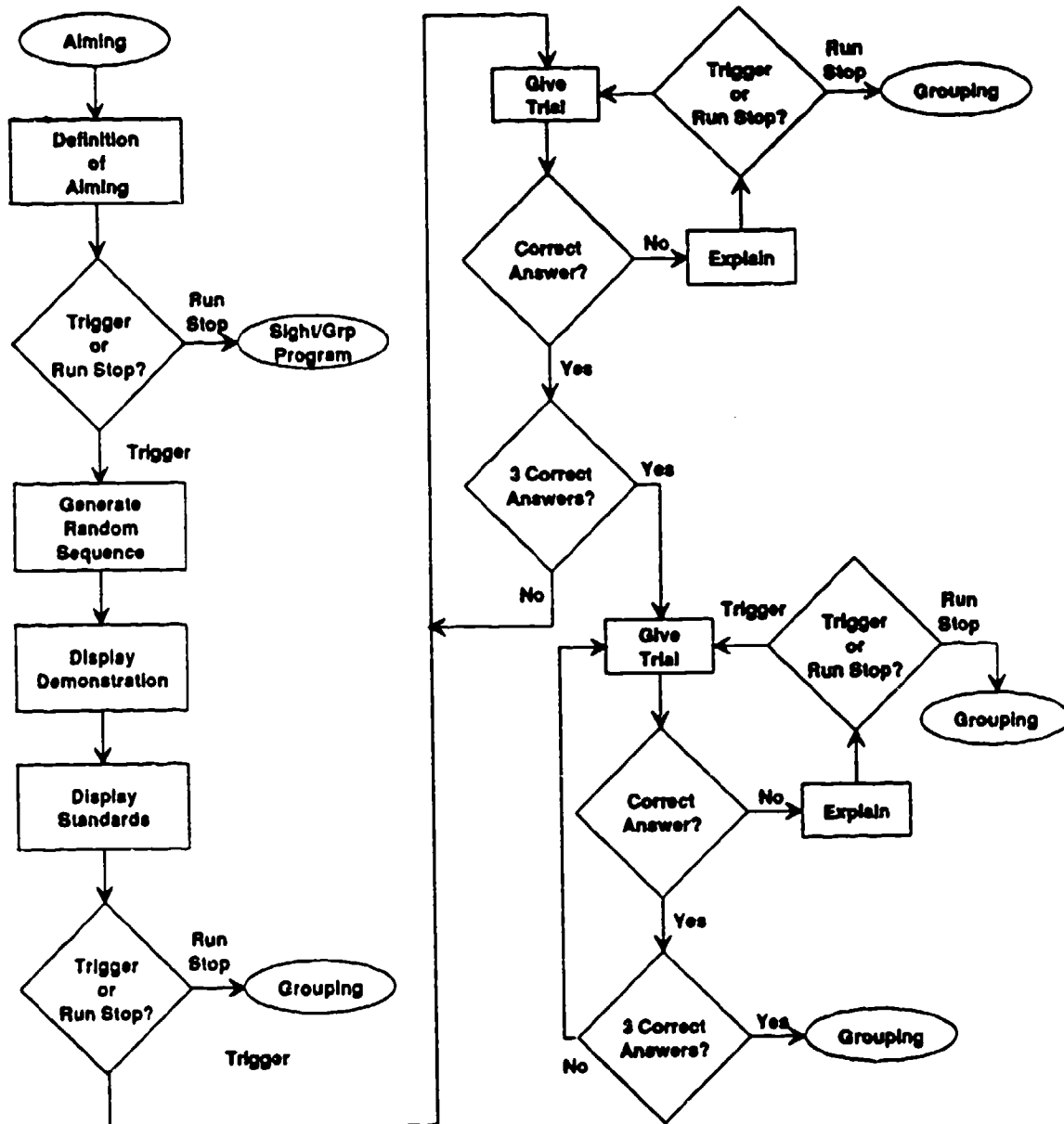


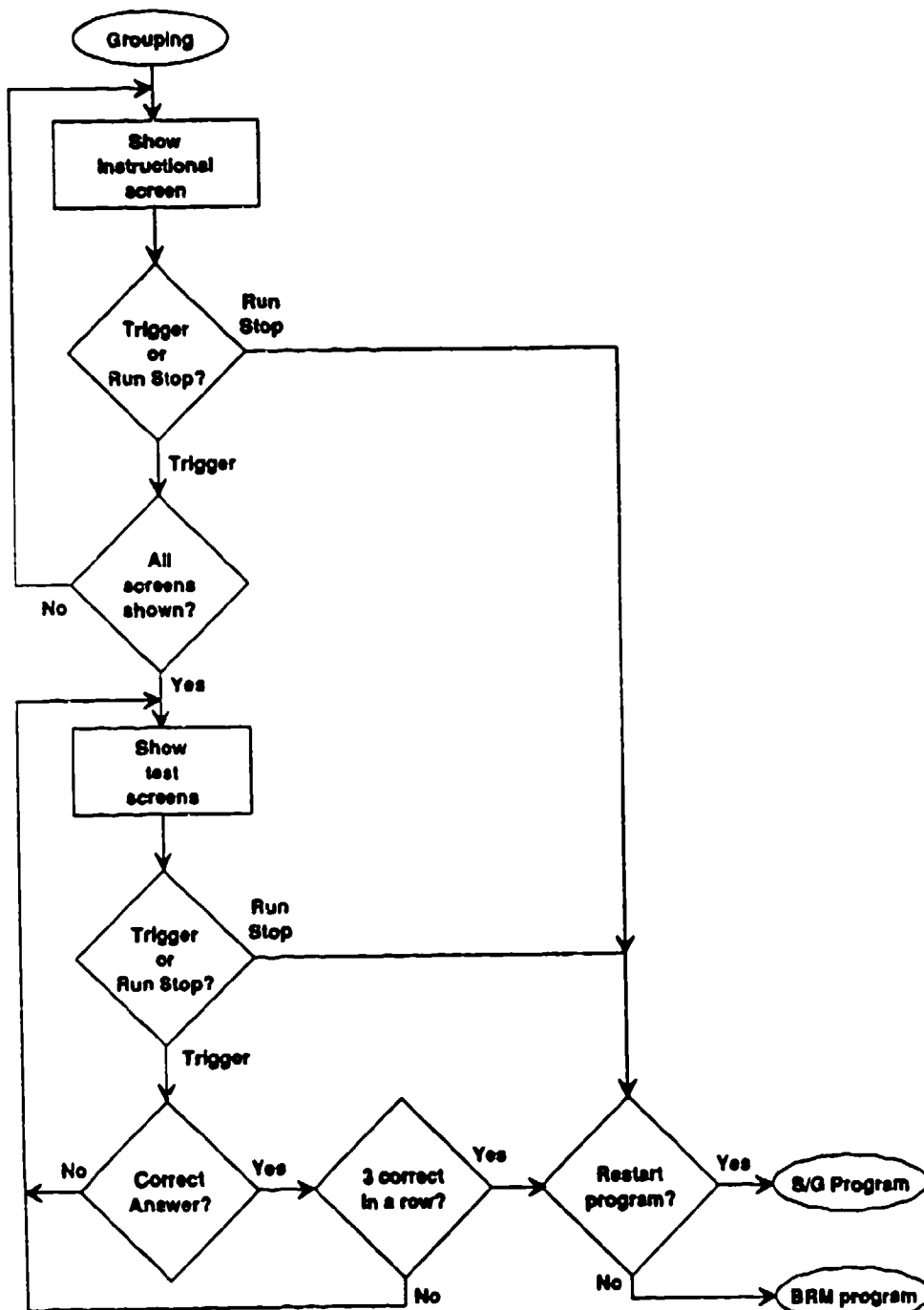
APPENDIX E

Programming Flow Chart for the Sight Alignment and Grouping Program









APPENDIX F

BRM Program Documentation

Basic Hierarchy Chart.

Lines 10-310: Main program driver.

Lines 1000-2890: Subroutines for firing levels.

Lines 1000-1640: Establish shot group/extended skills tests procedure.

Lines 1650-1930: Firing levels 1 and 2.

Lines 1940-2300: Firing levels 3 and 4.

Lines 2310-2730: Firing levels 5-8.

Lines 2740-2890: Firing level 9.

Lines 3000-5860: Supporting subroutines.

Lines 6000-6140: Data.

Lines 10-310: Main program driver.

Lines 10-70: Initialize variables.

Lines 80-120: Lines 80-310 form the main loop of the program. At this time, the BRM cartridge opening screen is being shown alternatively with the high scorer screen (after someone has fired). These lines poll the keyboard for the spacebar, the break key, or the "LP" or "SG" key combinations which enter the 9-level scenario, go to the menu, or run the light pen mount adjustment, or sighting and grouping programs respectively.

Lines 130-220: Line 130 transfers control to line 230 if variables have been initialized and the option of record keeping has been established. Otherwise, these lines welcome the user to MACS, and initialize array variables.

Lines 230-310: These lines send the firer first to the zeroing routine, and then to the appropriate level of fire. Upon completion of the exercises, the congratulations screen is displayed and control returns to the top of the program at line 80.

Lines 1000-1640: Establish shot group/extended skills tests procedure.

Lines 1000-1010: If the record keeping option has been specified, the user must now input the firer's identification number.

Lines 1020-1120: These lines show the instructional zeroing screen and check for the trigger to be pulled, or the "@" key to be pressed. If the trigger is pulled, the variable TN is set to 0 and the zero targets are shown with a random horizontal (X) value. If the "@" key is pressed, TN is set to -1 and the zero targets are displayed with the same X value (165). The machine language routine which draws expanded targets from the sprite data (referenced by the BASIC variable DT) is called to draw the 150-meter target (expanded to 50 meters). Line 1050 calls this routine and shows a center dot representing center of mass of the target.

Lines 1130-1150: These lines initialize the variables needed by the interrupt routines and copy the zero target data from its permanent location on the EPROM to its useful place in RAM. This routine is referenced by the BASIC variable DA.

Lines 1160-1200: If the shot number is 0 or 3, i.e., if the user is about to fire the first shot of either firing position, the accumulator for the average diagnostic scores (for the summary) is set to 0 and the firer is instructed to assume the proper position. The high resolution graphic screen must also be displayed at this point.

Lines 1210-1220: The appropriate X coordinate (either 165 or random, as determined by the value of TN) is put into the target data.

Line 1230: The target control and lightpen reading routine is called. If the routine returns to BASIC as a result of the break key's being pressed, control returns to line 1210 and the firer engages another target without advancing the shot counter.

Line 1240: Compute the diagnostic scores.

Lines 1250-1270: If the shot count is less than 3, the lightpen offset x and y values (OX and OY) are incremented. Each (X,Y) coordinate for bullet strike is examined to make sure it is within a range left and right of the target and immediately below. This range is the same as in the calibration program, assuming the calibration cross is the center of mass of the 250 meter target now being fired at. If a shot is determined to be out of range, the flag BC is set to 1.

Lines 1280: The accumulators for the average steady position and trigger squeeze scores are adjusted. Only these two scores can be computed now because no lightpen offset has been determined.

Lines 1290-1440: These lines are executed only if the shot count is at 2 (after the third shot has been fired). If a shot was determined to be out of range, the message "INVALID SHOT GROUP, TRY AGAIN" is displayed. If this is not the first invalid shot group, the additional prompt "CHECK CALIBRATION (SEE MANUAL)" is shown. The firer must then repeat the calibration process at line 1130 or press the stop key and enter the calibration program. If all shots were in range, the lightpen offsets can now be determined since the zeroing process has been completed, and the aiming and shot location scores for the first three shots can be computed (SYS 3427). The three-round shot group and summary diagnostic scores are shown. If the summary scores meet the standard, the firer fires three more shots. If the standard was not met, the program returns to line 230.

Line 1450: If the shot count is less than 6, the program loops back to line 1160.

Line 1460-1470: The shot location scores for shots 3-5 are computed and the three-round shot group and summary diagnostic scores are shown.

Lines 1480-1490: The program determines a starting level or continues to the extended skill test. If no further testing is required, control is returned to line 230.

Lines 1500-1540: Variables for the extended skill test are set up and the introductory screens displayed.

Lines 1550-1640: Either three or six more shots are fired in this loop for the extended skill test. These lines proceed in similar manner to the regular skill test with the exception of line 1570, which must now consider the possibility of a no fire. Control is returned to line 230 upon completion.

Lines 1650-1930: Firing levels 1 and 2.

Lines 1650-1660: The targets are shown at all ranges and the expanded target with the "bull's eye" circles is now shown.

Lines 1670-1680: Variable initialization.

Lines 1690-1710: If the current level is 1 and the "EZ" option has been selected, only the data for 250 meter targets is moved. The line which loads all other targets is skipped.

Line 1720: This line moves the data for all targets from EPROM.

Lines 1730-1780: All variables are initialized, and the hires scenario and status line are displayed. A random X coordinate and the no time limit

code are recorded in the data for the machine language routines and the trajectory and Y coordinate are obtained from the data for use in future BASIC routines. If the 50 meter target is being engaged, the second sprite is prepared.

Lines 1790: The machine language routine target and lightpen control is called here. POKE 878,0 turns off the cross delay counter so that the cross will remain on the screen and not disappear after one half second. If the break key is pressed during engagement, control is transferred to line 1930 and the subroutine is exited.

Lines 1800-1840: If the "call your shot" option is in effect, the program displays the message "CALL YOUR SHOT: 5." Each second from 5 to 0 is counted down and displayed. When the timer reaches 0, the crosshair is displayed.

Line 1850-1870: If a hit is detected, the prompt "HIT" is shown at the bottom left of the screen. If a miss is reported, the word "MISS" appears. The replay routine is called with a check for the break key.

Line 1880: The shot counter is incremented and if it is not the third shot at any target, the target data pointer is restored to the same target and the program loops back to line 1750.

Line 1890-1910: At this point in the routine, three shots have been fired at a target. The shot group is displayed and if the number of hits is 2 or 3, the next target is engaged (beginning at line 1730). If this success comes after an earlier failure, the message 'STANDARD MET, CONTINUE.' is displayed.

Line 1920: This line indicates the firer did not pass the standards. The number of repetitions counter (RP) is incremented, the "YOU DID NOT MEET THE STANDARD. PREPARE TO REFIRE." message is displayed, the border is changed to red, the number of hits (H) is set to 0, and control is sent to line 1750 for replay of the same target.

Line 1930: All sprites are turned off, summary diagnostic scores are displayed, the next level of fire is determined, and control is returned to line 280.

Lines 1940-2300: Firing levels 3 and 4.

Lines 1940-2060: The proper instructional screens are displayed, all variables are initialized and the target data is moved to RAM in random order.

Lines 2070-2110: These lines control the firing for the first round of targets. The work horse of this routine is the subroutine beginning at line 4850, which returns (in the variable Z) 128 if the break key is pressed during the exercise, 64 for a no fire, or 0 to proceed. When all targets have been engaged once, the next set of lines are executed to handle any necessary repetitions.

Line 2120: The summary shot groups for all targets engaged are shown.

Lines 2130-2240: Shots are refired on the targets for which the firer did not qualify. Again, the main routine is the subroutine beginning at line 4370.

Lines 2250-2300: The average diagnostic scores are computed and displayed and the next level of fire is determined. Control is returned to line 280.

Lines 2310-2730: Firing levels 5-8.

Lines 2310-2410: Instructional screens are displayed, all variables are initialized and the target data for the appropriate level (supported position) are moved to RAM.

Lines 2420-2460: The main routine at subroutine 4510 is called in line 2420. A summary of hit, miss, no fire, accuracy, and penalties is shown after firing. If the break key was pressed during engagement, the subroutine is exited. After shot groups are shown, the program checks to see if the standards have been met and either returns to line 2380 or continues to the unsupported position.

Lines 2470-2530: Instructional screens are displayed, all variables are initialized and the target data for the appropriate level (supported position) are moved to RAM. The main routine at subroutine 4510 is called in line 2530.

Lines 2540-2580: After the hit, miss, no fire, accuracy, and penalty summary screen is shown, the shot groups for all targets engaged are shown and records for the unsupported position are saved to disk if requested. If standards have not been met, control returns to line 2500.

Lines 2590-2730: The hit, miss, no fire, accuracy, and penalty summary screen is shown for both firing positions and the next level of fire is determined.

Lines 2740-2890: Firing level 9.

Lines 2740-2800: Instructional screens are displayed, all variables are initialized and the target data for level 9 are moved from EPROM to RAM. The high resolution graphics screen and status line are displayed.

Lines 2810-2890: The machine language routine controlling the target engagement and lightpen collection is entered. Due to the unique timing which is utilized in this level, all targets are displayed by this machine language routine, therefore, very little is done in BASIC. The positions are repeated (with shot groups and record storage to disk in between) until standards are met or the break key is pressed. After successful completion, the current level (CL) variable is set to 10 to signify the conclusion of the program and control is returned to line 280.

Lines 3000-3040: These lines perform the calculations for the diagnostic scores. For the steady position score, SD(0,S) is initially set to -1. Assume there are n readings. If n is greater 45, SD(0,S) is set to examine the readings from -45 to -7. If n is less than 45 but greater than 6, SD(0,S) is set for readings n to -7. The range of readings for the aiming score is set to the same value as that of the steady position. For the trigger squeeze measure, SD(2,S) is set to -1. If there are more than 5 readings, it is changed so that readings -6 to -1 are examined. The machine language routine (MA) is then called to compute the scores.

Lines 3050-3060: Certain variables are saved into the array H%.

Lines 3070-3080: Variables which were saved in lines 3050-3060 can be restored by calling this routine.

Lines 3090-3180: With the numeric diagnostic scores in the SD array, this routine returns the appropriate descriptive diagnostic score. It is most often called at line 3090, but in certain circumstances, may be called at line 3100 with the diagnostic score in Z4 and the subscript for criterion comparison in Z5. If the current level is 0 (zeroing procedure) and the NU variable (a flag for numeric scores) is not equal to 0, both the descriptive and numeric diagnostic scores are displayed simultaneously.

Lines 3190-3290: The ASSUME (proper) POSITION message is displayed. If PS is 0, the position is supported. For a 1 in PS, it is unsupported. If B\$ is not the null string, it is displayed above the ASSUME POSITION message. This routine is sometimes called at line 3250 to display the <PULL TRIGGER TO CONTINUE> message, at line 3260 to check for trigger pull, or at line 3280 to check for trigger release.

Line 3300: This procedure prints the string in A\$ to the graphics screen by calling the appropriate machine language routine.

Line 3310: The hires graphics screen at location S1 of chip/bank S2 is displayed.

Lines 3320-3350: The average diagnostic scores from B to E are computed.

Lines 3360-3410: Determines the appropriate next level of fire based on skill test performance.

Lines 3420-3480: These lines display the introductory screen to each level. If the trigger is pulled, the corresponding level is entered. If the break key is pressed, control is transferred to the menu screen.

Lines 3490-3930: The menu screen. This routine displays the options available to the user, including "L" (selecting start and stop levels), "N" (returns a new firer to the calibration routine), "W" (sets wind speed), "CS" (selects or deselects the "call your shot" option), "G" (returns to the level where the program was interrupted), and "EZ" (show only 250 meter targets on level 1).

Lines 3940-3970: Sprite initialization for the machine language replay routine.

Lines 3980-4290: Display diagnostic scores and replay for levels 1-4.

Lines 3980-4040: Display diagnostic scores. If a miss was detected, the word "MISS" is shown in place of a shot location score.

Lines 4050-4290: Show replay. The replay target is positioned so that its center of mass is at the point (254,176). The sight post which represents the perfect sight picture is adjusted for wind and trajectory. The replay message is displayed and the center of the screen is colored green by the machine language routine referenced by the variable CO. The replay is interrupt driven, and lines 4150-4170 wait for the replay to finish at least once before the trigger can be pulled. Lines 4200-4280 control the pause when the "Correct Sight Placement/Your Sight Placement" and "Pull trigger to continue" messages are displayed, waiting for either trigger pull, the break key, or the time limit to expire before showing the replay again.

Lines 4300-4450: Display final diagnostic scores for levels 1-4 and determine the next firing level.

Line 4300: If less than two shots have been fired, the summary scores are not displayed.

Lines 4310-4340: Compute the average diagnostic scores.

Lines 4350-4390: Display the final scores.

Lines 4400-4450: Determine the next firing level. If there is more than one poor score and the current level is greater than 1, the firer must regress a level. If there is a poor score or a score which is below

average, the firer must repeat the level. Otherwise, the firer attempts the next level.

Lines 4460-4510: A stack beginning at 16325 is used to store target numbers before the machine language routine referenced by the variable RM is called. By randomizing the numbers in the stack, the RM procedure can take the corresponding target from the data stored on the EPROM and place it in RAM. Before calling this subroutine, the variables B and E must be set to the beginning and ending point in the stack. This technique is used to accommodate those circumstances where two or more sets of targets must be randomized. For levels 5-8, the supported targets must be dealt with before the unsupported targets so that they are not all randomized together. This subroutine randomizes the stack so that the RM procedure can be called.

Lines 4520-4620: Main scenario routine for levels 5-8.

Lines 4520-4580: These lines perform the initialization process which varies for each level. The variable AD considers the different feedback for hit or miss (cross always, cross only for misses, or cross never) and whether or not the records should be saved to the disk buffer (remember that only the first attempt is saved).

Lines 4590-4610: The machine language target control routine is called, the whistle is blown if a target is left standing after the time limit has expired, and the procedure waits for the cross to disappear before continuing.

Line 4620: A random delay before the next screen is displayed.

Lines 4630-4690: Display shot groups. The target is positioned so that its center of mass is at (174,150) and the shots are displayed by the machine language routine referenced by the variable GP. The shot location score is returned in Z4. This result was once displayed at the bottom of the shot group screen.

Lines 4700-4850: Display the summary screen of hits, misses, no fires, shot location, and penalties for levels 5-8. It will also display the messages "Standard met" or "Standard not met."

Lines 4860-5050: Main scenario routine for levels 3-4.

Lines 4860-4920: All variables are initialized and the high resolution graphic screen with status line is displayed. The machine language routine which displays the targets is called.

Line 4930-4940: Hit, miss, or no fire is determined. If the break key was pressed or a no fire was recorded, the subroutine returns to line 2090.

Lines 4950-5050: The diagnostic scores are displayed and the replay is shown if a bad shot is determined. A bad shot is indicated by a poor score in any diagnostic measure or a below average or poor score for shot location.

Lines 5060-5150: Display diagnostic scores and shot group for the skill test.

Lines 5160-5240: Display summary screen for level 9.

Lines 5250-5270: Display four fundamentals of rifle marksmanship.

Lines 5520-5540: The "YOU DID NOT MEET THE STANDARD. PREPARE TO REFIRE." message is displayed and the border is changed to red to signify more target presentations due to a failure to meet standards.

Lines 5550-5560: The message "STANDARD MET. CONTINUE." is shown when a student has failed a standard, and then successfully meets a standard.

Lines 5570-5600: These lines display the status line after adding the current wind speed and direction.

Lines 5610-5680: This subroutine prompts the user for input at the menu screen. The menu is displayed on the high resolution graphic screen, necessitating a more complex means of obtaining the input. Only two characters or numbers are accepted.

Line 5690: The record keeping buffer is initially set for no fires.

Line 5700: This subroutine calls machine language routines from chip 0, bank 1. The variable SB should be set to the low byte of the address of the routine desired.

Line 5710: This routine performs the same function as in line 5700, except parameters can be passed through the variable Z.

Lines 5720-5730: The graphic depiction of the diagnostic scores ("bull's eye" target) and the target ranges are shown.

Lines 5740-5810: Displays examples of the proper offset for wind effects.

Lines 5820-5860: Checks the number of hits and determines if the firer was an expert, marksman, sharpshooter, or unqualified. If H%(0)=1, the firer had an earlier repetition and therefore can be rated only as high as sharpshooter.

Lines 6000-6120: Data.

APPENDIX G

MACS BRM Cartridge Program Listings

```

10 POKE 800,237:V=53248:POKE 53281,0:POKE V+21,0:B=0 "15L-1:BL-9:BO-1
20 DIM SD(3,25),CR(9,3),RA(8),DA(6,10),CR8(5)
30 I1=43640:I2=43994:WU=0:BL=0:CR=0
40 DEF FWH(X)=INT(X/256):DEF FNL(X)=X-INT(X/256)*256
50 DEF FWH(X)=FWH(X)+FWH(X+1)*256:DEF FNL(X)=INT((ABS(X)*X)+.5)
60 RK=256:RM=3460:DS=3403:RT=3406:RV=3409:RAMO=3415:SC=3421:MA=3424:LC=3430
70 GP=3433:CO=3436:WH=3439:NS=3442:DT=3445:T=0
80 IF FWH(56321)=127 THEN SYS DS:GOSUB 3490:GOTO 130
90 IF FWH(56321)=247 THEN GOSUB 3260:POKE 53280,0:SYS DS:GOTO 130
91 IF RK=256 THEN 100
92 T=T+2:IF T<800 THEN 100
93 IF (T AND 1)=1 THEN SYS 49188:T=0:GOTO 80
94 POKE 871,3:SYS RA:A=-(LGRM)(F2)0823<Pull trigger to begin>":GOSUB 3300:T=1:GOTO 80
100 GET A:IF A=0 THEN 80
110 B=RIGHT$(B,1)+A:S=-(B=0)*1)-(B=0)*9)*2:IF S=0 THEN 80
120 SYS DS:POKE 53265,27:POKE 53272,23:PRINT"(CLR)":POKE 4161,2:SYS 49178
130 IF RK=256 THEN 230
140 A=-(F2)09(F6)00(F3)00(F7)00(CLR)(F2)1302(F1)(GRM)M A C 4(F2)0905(LBLU)Basic Rifle(F2)0802Marksmanship(F2)1211"
150 A=A+Training(RND)(F3)00":GOSUB 3300
160 POKE 53281,0:FOR I=0 TO 9:FOR J=0 TO 3:READ CR(I,J):NEXT J,I
170 FOR I=1 TO 6:FOR J=0 TO 4:READ DA(I,J):NEXT J,I
180 FOR I=1 TO 5:READ CR8(I):NEXT I
190 RM=S+0:SB=15:GOSUB 5710:RK=2
200 RK=0:FOR I=1 TO 500:NEXT I:IF RK=0 THEN 230
210 POKE 53265,27:POKE 53272,23:INPUT"(CLR)Data"/A:IO=LEFT$(A,8)+CHR$(13)
220 INPUT"Unit"/A:IO=IO+LEFT$(A,20)+CHR$(13)
230 POKE 914,0:BL=0:CL=0:MO=0":GOSUB 1000:IF CL=BL THEN CL=BL
240 IF CL=BL THEN CL=BL
250 GOSUB 3420:BC=BL:IF CL=0 THEN 230
260 IF (W1 AND 16) THEN W1=INT(RND(1)*5):W1=16+((W1-(W1-4)*2)+(INT(RND(1)*8)*32)
270 POKE 914,W1:ON CL GOSUB 1650,1650,1940,1940,2310,2310,2310,2740
280 MO=0":IF (CL<BL) AND (BL<CL) THEN 240
290 A=-(F2)09(F6)03(CLR)(F3)05(F7)05(BLK)(F2)0504(F1)CONGRATULATIONS(F8)(F8) You are finished(F8) with this "
300 A=A+program.(F8)(F8) Call instructor.(F1)":GOSUB 3250
310 POKE 53280,0:SYS 49188:RESTORE:POKE 198,0:GOTO 80
1000 TH=0:H(0)=0:SL=32768:S2=0:IF RK=0 THEN 1020
1010 POKE 53272,23:POKE 53265,27:INPUT"(CLR)(WHT)Firer ID #"/ID:ID=LEFT$(ID,20)
1020 GOSUB 5250:POKE 53265,43:A=-(F6)00(F5)13(F7)00(CLR)(BLK)(F1)(F2)0701First 3 shots"
1030 A=A+"(F2)0003establish shot group(F2)0105Aim center of mass."
1040 A=A+"(F2)0517White dot shows(F2)1319center."":GOSUB 3300
1050 POKE 880,3:SYS DT:FOR S=12196 TO 12199:POKE S,15:NEXT S:POKE 1524,1
1060 A=-(F2)0723<Pull trigger to continue>(F3)00":GOSUB 3300
1070 IF FWH(56321)=247 THEN 1100
1080 GET A:IF A<>"0" THEN 1070
1090 TH=1
1100 GOSUB 3280:IF W1=0 THEN 1130
1110 A=-(F3)09(F5)00(F7)00(F1)(GRM)(F2)0904There is no(F2)0607wind while you(F2)0410are establishing"
1120 A=A+"(F2)0913shot group.(LGRM)(F1)":GOSUB 3250
1130 BC=0:POKE 899,42:POKE 893,60:POKE 838,0:FOR I=834 TO 837:POKE I,0:NEXT I
1140 OK=0:OY=0:POKE 838,0:POKE 889,0:POKE 890,160:POKE 891,40:POKE 892,100
1150 POKE 823,0:POKE 824,0:POKE 821,17:POKE 822,0:SB=6:GOSUB 5700:S=0
1160 IF (S<>0) AND (S<>3) THEN 1210
1170 FOR S=0 TO 3:SD(2,25)=0:NEXT S:PS=INT(S/3)
1180 B=-(F1)(F2)0303(GRM)Next 3 shots help(F2)0106decide start level."":IF PS THEN 1200
1190 B=-(F1)(F2)0301(GRM)Fire one shot per(F2)1304target.(F2)0007targets are unlimited."
1200 GOSUB 3190:GOSUB 3310
1210 POKE 876,0:POKE 877,205:X=-(INT(RND(1)*75)*2)+71:IF TW THEN X=165
1220 POKE 52481,X:GOSUB 3250
1230 S=-20352:SB=0:GOSUB 5710:POKE V+21,0:IF S=128 THEN 1210
1240 M=FWH(907):M=M+(M+128)*(M-128):GOSUB 3000
1250 IF S=2 THEN 1280
1260 X1=-(X+11)-FWH(847):Y1=165-FWH(849):OX=OX+X1:OY=OY+Y1:SD(1,S)=2
1270 IF (X1>73) OR (X1<-148) OR (Y1>17) OR (Y1<-47) THEN BC=1
1280 SD(0,25)=SD(0,25)+SD(0,S):SD(2,25)=SD(2,25)+SD(2,S)
1290 GOSUB 3280:IF S<2 THEN 1450
1300 OX=INT((OX/3)+.1):OX=INT(OX/2)*2:OY=INT((OY/3)+.5)
1310 IF (BC=0) OR (SO=0) THEN 1370
1320 A=-(F3)09(CLR)(RED)(F5)00(F7)00(F1)(F2)0204Invalid shot group(F2)1107try again":IF H(0)=0 THEN 1340
1330 A=A+"(F2)0310or check lightpen(F2)0513mount alignment(F2)0816(see manual)"
1340 A=A+"(F1)(LGRM)":H(0)=1:GOSUB 3250
1350 IF BA THEN S=1:GOTO 120
1360 GOTO 1130
1370 X=OX-(OX<0)*65536:Y=OY-(OY<0)*65536
1380 POKE 834,FNL(X):POKE 835,FWH(X):POKE 836,FNL(Y):POKE 837,FWH(Y)
1390 SD(1,0)=SD(1,0):SYS 3427:FOR S=0 TO 2:SD(1,25)=SD(1,25)+SD(1,S)
1400 SD(2,25)=SD(2,25)+SD(2,S):NEXT S:S=43640:GOSUB 5060
1410 A=-(F3)08(CLR)(F5)00(F7)00(F1)(WHT)shot group+CR8+(SWLC)(LBLU)(F2)0304Would you like to(F2)1107try for a"
1420 A=A+"(F2)0610lighter group(F1)(F2)0523(GRM)Pull trigger to select answer(F2)0017(F3)08"
1430 GOSUB 3300:SB=18:GOSUB 5710:POKE 53265,43:IF S THEN 1130
1440 B=0:S=2:GOSUB 3370:S=2:IF (S=0) OR (BL<2) THEN CL=1:RETURN
1450 S=S+1:IF S<6 THEN 1160
1460 POKE 53265,43:FOR S=3 TO 5:SD(1,25)=SD(1,25)+SD(1,S)
1470 SD(2,25)=SD(2,25)+SD(2,S):NEXT S:S=43644:GOSUB 5060
1480 S=6:T=0
1490 S=3:S=5:GOSUB 3370:IF (S=0) OR (BL<2) THEN CL=2:RETURN
1500 B=-(F1)(F2)0101(GRM)You have done well!(F2)1304How try(F2)0607timed targets."
1510 PS=0:GOSUB 3190:GOSUB 5690
1520 POKE 838,0:POKE 889,0:POKE 890,160:POKE 891,40:POKE 892,100:POKE 876,0
1530 POKE 877,205:POKE 823,17:POKE 824,0:POKE 821,114:POKE 822,0:SB=6:GOSUB 5700
1540 POKE 899,42:GOSUB 3310:B=0:S=2:T=1
1550 FOR S=B TO 5
1560 SB=0:S=-20352:GOSUB 5710:POKE V+21,0

```

```

1570 IF E>63 THEN SYS WH:FOR S=0 TO 3:SD(E,S)=CR(S*P8*4.3):NEXT S:GOTO 1590
1580 M=FNH(807):M=M+(M>128)*(M-128):GOSUB 3000
1590 GOSUB 3280:NEXT S:GOSUB 3370:IF (E<0) AND (E>(T+2)) THEN 1610
1600 M=6:CL=1+2:BS="":GOTO 1630
1610 T=T+1:IF T=2 THEN PS=1:BS="":GOSUB 3190:GOSUB 3310:B=3:E=5:GOTO 1550
1620 M=6:CL=5:BS="(F2)1005Well done!"
1630 AS="(F3)09(CLR)(F5)00(F7)00(GRM)(F1)+BS+(F2)0308You will start at (F2)1511. . .(F3)00"
1640 GOSUB 3100:FOR D=1 TO 800:NEXT D:RETURN
1650 GOSUB 3720:GOSUB 3740:WT=3:P8=CL-1:BS="(F1)(F2)0002(GRM)Targets are untimed."
1660 BS=BS+(F2)0003Standard: Hit 2 of 3(F2)0308at each distance.:GOSUB 3190
1670 GOSUB 3690:POKE 876,0:POKE 877,205:POKE 889,0
1680 POKE 890,160:TH=0:POKE 891,40:POKE 892,180:POKE 898,0:POKE 899,42
1690 IF (E=0) OR (CL<1) THEN 1720
1700 FOR S=0 TO WT*6-1:POKE 16325+S,4:NEXT S:POKE 16325+WT*6,255
1710 POKE 821,0:POKE 823,114:POKE 824,0:SB=3:GOSUB 3700:GOTO 1730
1720 POKE 823,114:POKE 824,0:POKE 821,225:POKE 822,0:SB=6:GOSUB 3700
1730 S1=32768:S2=8:IR=-32640-(C8*4096):M=0:TH=TH+1:RP=0:IF TH=7 THEN 1830
1740 GOSUB 3050
1750 S=PEEK(838):GOSUB 3310:AS="L"+STR$(CL)+"T"+STR$(S+1)+"R"+STR$(RP)
1760 GOSUB 3570:POKE 12+7+S*8,RP:X=(INT(RND(1)*65))*2+71:AD=FNH(876)
1770 POKE AD+1,X:Y=PEEK(AD+2):POKE AD+6,255:TJ=PEEK(AD+11):TJ=TJ+(TJ>127)*256
1780 IF (TH=1) AND ((E=0) OR (CL<1)) THEN POKE AD+15,X*40:POKE AD+20,255
1790 GOSUB 3950:SB=0:E=IR:GOSUB 3710:POKE 878,0:IF S=128 THEN 1930
1800 IF C8=0 THEN 1850
1810 AS="(F2)0423(BLK)(SWLC)(F1)Call your shot!":S1=TI+359
1820 S2=INT((S1-TI)/60):AS=AS+(F2)3423+STR$(S2):GOSUB 3300:AS="(F1)"
1830 IF S2>0 THEN 1820
1840 POKE V+21,PEEK(V+21) OR 1
1850 AS="(BLK)(F1)(F2)0423 (F2)0123+C8R4(142)
1860 BS="also":IF PEEK(900)<28 THEN M=M+1:BS="hit"
1870 AS=AS+BS:GOSUB 3300:GOSUB 3980:IF S=128 THEN 1930
1880 S=8+1:IF S/3<>INT(S/3) THEN POKE 876,H4(2):POKE 877,H4(3):GOTO 1750
1890 M=3:S=11:H4(1)*8:GOSUB 4630:IF M<2 THEN 1920
1900 IF RP>0 THEN TH=BC-BL:GOSUB 3530
1910 GOTO 1730
1920 GOSUB 3070:IR=-31616-(C3*4096):RP=RP+1:M=0:GOSUB 3520:GOTO 1750
1930 POKE V+21,0:GOSUB 4300:CL=CL+A:RETURN
1940 RP=0:P8=CL-3:WT=4:GOSUB 3740
1950 AS="(F3)09(F6)00(CLR)(F5)00(F7)00(GRM)(F1)(F2)030324 timed targets.:IF CL=4 THEN 1980
1960 AS=AS+(F2)0007Standard: Hit 3 of 4(F2)0310at each distance."
1970 AS=AS+(F2)0614Replay for Bad(F2)0917shots only.(F1)(LGRM)":GOSUB 3210:BS="":GOTO 2010
1980 AS=AS+(F2)1107Standard:(F2)0010Hit 3 of 4 at ranges(F2)0012between 50 and 200 m"
1990 AS=AS+(F2)0715Hit 2 of 4 at (F2)0717250 and 300 m(F1)(LGRM)":GOSUB 3250
2000 BS="(F1)(GRM)(F2)0604Replay for Bad(F2)0907shots only."
2010 GOSUB 3190:POKE 33265,43:GOSUB 3690:IR=-32640:POKE 899,42
2020 B=0:E=WT*6-1:GOSUB 4460
2030 AD=11:FOR S=1 TO WT*6:POKE AD,255:AD=AD+8:NEXT S:S1=37445:S2=8
2040 FOR S=8 TO E:POKE 16325+S,INT(PEEK(16325+S)/WT):NEXT S:FOR S=1 TO 6
2050 DA4(S,5)=0:DA4(S,6)=0:NEXT S:FOR S=1 TO 11*199 STEP 8:POKE S,0:NEXT S
2060 POKE 821,0:POKE 823,114:POKE 824,0:SB=3:GOSUB 3700:POKE 876,0:POKE 877,205
2070 I=0:GOSUB 3310
2080 I=1+1:IF I>WT*6 THEN 2120
2090 GOSUB 4860:POKE V+21,0:IF S=128 THEN 2250
2100 IF S=64 THEN SYS WH
2110 GOTO 2080
2120 FOR TH=1 TO 6:S=11+(TH-1)*32:M=4:GOSUB 4630:NEXT TH:F=1
2130 POKE 33265,43:RP=RP+1:ER=0:TH=1
2140 IF DA4(TH,3)>=3+((CL=4) AND (TH>4)) THEN 2270
2150 ER=1:IR=-31616:POKE 821,0:POKE 823,114:POKE 824,0:IF F THEN GOSUB 3520
2160 AD=11+(TH-1)*32:FOR S=1 TO 4:POKE AD,255:AD=AD+8:NEXT S
2170 FOR S=0 TO WT-1:POKE 16325+S,TH-1:NEXT S:POKE 16325+WT,255:SB=3:GOSUB 3700
2180 POKE 876,0:POKE 877,205:DA4(TH,5)=0:DA4(TH,6)=0:GOSUB 3310
2190 GOSUB 4860:POKE V+21,0:IF S=128 THEN 2250
2200 IF S=64 THEN SYS WH
2210 I=FNH(1+1):IF DA4(TH,6)<WT THEN 2190
2220 S=11+(TH-1)*32:M=4:GOSUB 4630:F=0
2230 TH=TH+1:IF TH<7 THEN 2140
2240 IF ER THEN 2130
2250 POKE V+21,0:FOR J=0 TO 3:SD(J,25)=0:NEXT J
2260 M=0:FOR TH=1 TO 6:IF DA4(TH,6)=0 THEN 2290
2270 FOR I=1 TO DA4(TH,6):S=(TH-1)*WT+(I-1):M=M+1
2280 FOR J=0 TO 3:SD(J,25)=SD(J,25)+SD(J,S):NEXT J,I
2290 NEXT TH:A=0:BL=0:IF M>0 THEN GOSUB 4330
2300 CL=CL+A:RETURN
2310 GOSUB 3740:AS="(F3)09(F6)00(CLR)(F5)00(F7)00(GRM)(F1)(F2)040240 timed targets(F2)0205Randomly presented"
2320 AS=AS+(F2)0308single or double.(F2)021220 shots/supported"
2330 AS=AS+(F2)001520 shots/unsupported(F1)(LGRM)":GOSUB 3250
2340 PS=0:BS="(F1)(GRM)(F2)05027Fire at closest(F2)0404targets first or"
2350 BS=BS+(F2)0006penalty is recorded.(F2)0108Standard: 15 of 20.:GOSUB 3190
2360 GOSUB 3690:RP=0:IR=512
2370 H4(0)=0:S1=35050:S2=2:IF CL=7 THEN S1=37968:S2=2
2380 POKE 33265,43:B=0:E=15:GOSUB 4460:POKE 876,0:POKE 877,205:POKE 889,0
2390 POKE 890,160:POKE 891,40:POKE 892,180:POKE 898,0:POKE 899,20:POKE 910,0
2400 POKE 918,0:POKE 919,0
2410 POKE 912,0:TH=0:POKE 821,0:POKE 823,225:POKE 824,0:SB=3:GOSUB 3700
2420 GOSUB 4520:A=2:POKE 12+7,RP:HI=0:M=PEEK(838):IF (M=0) AND (A<128) THEN 2460
2430 AS="(F3)09(F6)00(CLR)(F5)00(F7)00(LBLU)(F2)0601SUMMARY: Supported Position":GOSUB 4700
2440 HI=21:HI=22:WT=23:AC=24:IF A=128 THEN BL=0:RETURN
2450 FOR TH=1 TO 6:S=11:GOSUB 4630:NEXT TH
2460 IF H1<15 THEN IR=1836:RP=RP+1:H4(0)=1:GOSUB 3520:GOTO 2380
2470 S4=AC:BC=BL
2480 PM=PEEK(912):TH=16:RP=0:P8=1:BS="(F1)(GRM)(F2)11048Standard:(F2)0707Hit 15 of 20."
2490 GOSUB 3190:POKE 899,40:POKE 33265,43:IR=512
2500 B=16:E=28:GOSUB 4460:POKE 876,0:POKE 877,205:POKE 889,176:POKE 890,164
2510 POKE 891,184:POKE 892,181:POKE 898,20:POKE 910,0:POKE 912,0
2520 POKE 918,2:POKE 919,0
2530 POKE 821,16:POKE 823,225:POKE 824,0:SB=3:GOSUB 3700:GOSUB 4320:A=1
2540 POKE 12+167,RP:HI=0:M=PEEK(838)-20:IF (M=0) AND (A<128) THEN 2580
2550 AS="(F3)09(F6)00(CLR)(F5)00(F7)00(LBLU)(F2)0501SUMMARY: Unsupported Position":GOSUB 4700

```

```

2360 H1=21:H1=22:HF=23:IF A=128 THEN BL=0:RETURN
2370 A=24:FOR TH=1 TO 6:2=11:160:GOSUB 4630:NEXT TH
2380 IF H1<15 THEN IR=1536:RP=RP+1:H1(0)=1:GOSUB 5520:TH=16:GOTO 2500
2390 POKE V+21,0:24=AC*(AC+24)/2
2400 H1=0:H1=0:HF=0:AS="(F3)09(F6)00(CLR)(F5)00(F7)00(LBLU)(F2)140(FINAL SCORES)"
2410 AS=AS+(F2)1303(GRM)H1=21:2199(RED)Misses(YELO)(F2)2999No Fires(F8)(F8)":GOSUB 3300
2420 FOR I=1 TO 6:2=2:DA(1,3)+DA(1,8):AS="(LBLU)(F2)0599*STR$(I+50)+(F2)1399(GRM)*STR$(I)
2430 H1=H1+2:2=2:DA(1,6)+DA(1,9):AS=AS+(F2)2299(RED)*STR$(I):H1=H1+2
2440 2=2:DA(1,7)+DA(1,10):AS=AS+(F2)3299(YELO)*STR$(I)+(F8)(F8):HF=HF+2:GOSUB 3300:NEXT I
2450 AS="(F2)0699(LBLU)TOTAL(F2)1399(GRM)*STR$(H1)+(F2)2299(RED)*STR$(H1)+(F2)3299(YELO)*STR$(HF)
2460 24=AC/25=9:GOSUB 3100:AS=AS+(F8)(F8)(LBLU)(F2)0699Penalties:"
2470 AS=AS+STR$(PEEK(812)+PM)+(F8)(F2)0699Overall shot location:"
2480 AS=AS+RIGHT$(CHR$(LEN(CHR$(3)+(F8)(F8):GOSUB 5820:AS=AS+CHR$(LGRM)":GOSUB 3250
2490 IF (2>2) OR (H1>35) THEN BL=0:CL=CL+1:RETURN
2500 IF 2=1 THEN A=(CL+BL):BL=6-A:CL=CL+A:BL="(F2)1599Poor":GOTO 2720
2510 BL=6-BL="(F2)0699below average:"
2520 AS="(F3)09(CLR)(RED)(F1)(F8)(F8) You are being sent(F8)(C/RT) back to level"+STR$(CL)+(F8)(F2)0699because"
2530 AS=AS+ your(F8)(F2)0399shot location was(F8)+BL+(F1)(LGRM)":GOSUB 3250:RETURN
2540 PS=0:GOSUB 5740:SD(0,0)=0:SD(1,0)=0
2550 BS="(F1)(GRM)(F2)090240 targets.(F2)0605Attack/Retreat(F2)1108scenario.":GOSUB 3190
2560 POKE 53280,0:RP=0:21=37968:2=2:GOSUB 3690:IR=4736:H1(0)=0
2570 POKE 876,0:POKE 877,205:POKE 889,0:POKE 890,160
2580 TH=0:POKE 891,40:POKE 892,180:POKE 898,0:POKE 899,40:POKE 912,0
2590 POKE 823,145:POKE 824,3:POKE 821,59:POKE 822,6:2B=6:GOSUB 5700
2600 GOSUB 3310:AS="L= 91T= 0|R="*STR$(RP):GOSUB 5570:POKE 918,0:POKE 919,0
2610 POKE 12+7,RP:2B=0:2=IR:GOSUB 5710:A=2
2620 POKE V+21,0:POKE 53280,0:H=PEEK(838):IF H=0 THEN RETURN
2630 BS="Supported Position":IF PS THEN BS="Unsupported Position"
2640 AS="(F3)09(F6)00(CLR)(F5)00(F7)00(LBLU)(F2)0601SUMMARY: "+2B:H=PEEK(838):GOSUB 5160
2650 IF A=128 THEN BL=0:RETURN
2660 FOR TH=1 TO 6:2=11:GOSUB 4630:NEXT TH
2670 IF H1<23 THEN IR=3712:RP=RP+1:H1(0)=1:GOSUB 5520:GOTO 2770
2680 SD(0,0)=SD(0,0)+H1:SD(1,0)=SD(1,0)+24
2690 BC=BL:RP=0:IF PS=0 THEN PS=1:2B="":GOSUB 3190:IR=4736:GOTO 2770
2700 CL=10:24=SD(1,0)/2:25=9:GOSUB 3100:POKE 785,FML(HS):POKE 786,FMH(HS)
2710 SD(0,0)=SD(0,0)+(2/10)-((H1 AND 96)=64)-((H1 AND 32)*5))^(H1 AND 7)
2720 POKE 871,1:2=USR(SD(0,0)):IF PEEK(924)>10 THEN RETURN
2730 POKE 871,0:2=USR(SD(0,0)):RETURN
2740 SD(0,0)=1:IF H>6 THEN SD(0,0)=(H-43)*256+(H-7):IF H<43 THEN SD(0,0)=H-7
2750 SD(1,0)=SD(0,0)
2760 SD(2,0)=1:IF H>5 THEN SD(2,0)=(H-6)*256+(H-1)
2770 POKE 785,FML(MA):POKE 786,FMH(MA):2=USR(2)
2780 RETURN
2790 H1(1)=PEEK(838):H1(2)=PEEK(876):H1(3)=PEEK(877):H1(4)=PEEK(889)
2800 H1(5)=PEEK(890):H1(6)=PEEK(891):H1(7)=PEEK(892):H1(8)=PEEK(899):RETURN
2810 POKE 838,H1(1):POKE 876,H1(2):POKE 877,H1(3):POKE 889,H1(4)
2820 POKE 890,H1(5):POKE 891,H1(6):POKE 892,H1(7):POKE 899,H1(8):RETURN
2830 24=SD(3,0):25=J+PS+4
2840 2=5:IF 24>CR(25,0) THEN 2=4
2850 IF 24>CR(25,1) THEN 2=3
2860 IF 24>CR(25,2) THEN 2=2
2870 IF 24>CR(25,3)OR(24<0) THEN 2=1
2880 CR=CR+(2):IF (CL<0)OR (MU=0) THEN RETURN
2890 BS=STR$(39-LEN(STR$(24)))+BS+RIGHT$(25,2)
2900 CR="(F1)(F2)2499*H1(6,10)+(F8)(F2)*BS+99*STR$(24)+(F8)(F1)":RETURN
2910 BS=STR$(24):24=LEN(BS):IF 24<4 THEN FOR 25=1 TO 4-24:BS=" "+BS:NEXT 25
2920 CR="(F1)(F2)2499*H1(6,10)+(F2)3599*BS+(F1)(F8)":RETURN
2930 POKE V+21,0:AS="(F3)09(CLR)(F6)00(F5)00:IF BS=" THEN AS=AS+(WHT)(F1)(F2)0008:B1="(F8)(F8)":GOTO 3210
2940 AS=AS+BS:GOSUB 3300:AS="(F1)(WHT)(F2)0012:B1="(F8)(F1)(F8)(F1)"
2950 IF PS THEN AS=AS+(F2)1199ASSUME /M+BS+(F2)0999UN":GOTO 3230
2960 AS=AS+(F2)1299ASSUME A+BS+(F2)1199"
2970 AS=AS+"SUPPORTED"+BS+(F2)1299POSITION"
2980 AS=AS+(F1)+BS+(LGRM)(F2)0823(Pull trigger to begin(F3)00:GOSUB 3300:GOTO 3260
2990 AS=AS+(F2)0723(Pull trigger to continue(F3)00:GOSUB 3300
3000 BR=0:IF PEEK(56321)=127 THEN BR=-1:GOTO 3280
3010 IF PEEK(56321)<247 THEN 3260
3020 IF PEEK(56321)<255 THEN 3280
3030 RETURN
3040 AS=AS:25=49182:RETURN
3050 POKE 253,FML(21):POKE 254,FMH(21):POKE 251,82:25=SC:RETURN
3060 REM GET AVERAGE ACROSS B-E SHOTS FOR EACH DIAGNOSTIC SCORE
3070 FOR 22=0 TO 3:SD(22,12)=0:NEXT 22
3080 FOR 21=0 TO 3:FOR 22=0 TO 3:SD(21,12)=SD(21,12)+SD(21,22):NEXT 22,21
3090 2=(2-B)+1:FOR 22=0 TO 3:SD(22,12)=SD(22,12)/2:NEXT 22:RETURN
3100 REM ROUTINE TO SEE IF SHOTS B-E FALL INTO RANGE FOR ADVANCEMENT
3110 FOR J=1 TO 5:H1(J)=0:NEXT J:GOSUB 3330
3120 FOR J=0 TO 3:2=12:GOSUB 3090:H1(2)=H1(2)+1:NEXT J
3130 IF (H1(1)>0)OR (H1(2)>0)OR (H1(3)>0)OR (H1(4)>0) THEN 2=0:RETURN
3140 2=1:RETURN
3150 AS="(F3)09(F6)00(CLR)(F5)00(F7)00(F1)(LBLU)(F2)1505LEVEL(F2)1709*B1-STR$(CL)
3160 AS=AS+BS+(GRM)(F2)0015:GOSUB 3300:POKE 823,CL:2B=21:GOSUB 5700
3170 AS="(LGRM)(F2)0723(Pull trigger to continue(F3)00:GOSUB 3300
3180 IF PEEK(56321)=247 THEN RETURN
3190 IF PEEK(56321)<127 THEN 3450
3200 GOSUB 3690:IF CL=0 THEN RETURN
3210 GOTO 3420
3220 POKE 53265,43:POKE 53272,31:POKE 198,0:AS="(F6)00(F5)00(F7)00(CLR)(GRM)Start level:"
3230 AS=AS+STR$(BL)+(GRV1)(F2)3399ARI8902(GRM)Final level:STR$(BL)+(F8)(BLU)Wind speed: "
3240 IF (H1 AND 16) THEN AS=AS+ Variable":GOTO 3340
3250 AS=AS+STR$(H1 AND 7)*3)+ MPH ":IF (H1 AND 7)=0 THEN 3340
3260 BS=STR$(INT(H1/32)+1):BS="0"RIGHT$(BS,1):AS=AS+(F4)*BS
3270 AS=AS+(BLK)(F8)(F8):GOSUB 3300:POKE 253,CL:POKE 254,21:POKE 823,0:2B=21:GOSUB 5700
3280 2=154-(BL+1)OR (BL<0)*4:AS=CHR$(2)+(F8) L: Select Start/Final Level(F8)(LBLU)"
3290 2="(LBLU)":IF (H1 AND 23) THEN 2="(YELO)"
3300 AS=AS+ N: New fire(F8)+25+ N: Set Wind Speed(F8)"
3310 BS="on "+25+(LBLU):IF 2 THEN BS="off "+25+(YELO)"
3320 AS=AS+24+CB: Turn "+BS+CHR$(34)+Call your shot+CHR$(34)+ option(F8)(LBLU)"
3330 AS=AS+LP: Light pen mount adjustment(F8)80: Sighting and grouping program(F8)"
3340 GOSUB 3300:BS="250 meters":25="(LBLU)":IF 2 THEN BS="all ranges":25="(YELO)"

```

G-4

```

4530 TH=TH+1:IF TH=2 THEN 2=0:RETURN
4540 IF CL=0 THEN 4570
4550 AD=FWH(76):T=PEEK(AD):AD=AD+1
4560 FOR S=1 TO 7:1=INT(((PEEK(AD+5)*2)/3)+.5):POKE AD+5,S:1=AD=AD+14:NEXT S
4570 AD=16512:(CL=3)-16560:(CL=6)-20600:(CL=6)+20400:(CL=6) AND (RP>0)
4580 2=AD:IF PEEK(838)>PEEK(899) THEN 2=4+1
4590 89=0:12=2+1:POKE 53280,BC:GOSUB 5710:POKE V+21,0:IF 2=128 THEN RETURN
4600 IF 2=64 THEN SYS MH
4610 IF PEEK(878)<0 THEN 4610
4620 11=(INT(RND(1)*31)+1)+750:FOR S=1 TO 31:NEXT S:GOTO 4530
4630 AS="(F3)09(F6)00(CLR)(F5)13(F7)00(BLK)":GOSUB 3300:POKE 785,FHL(GP):POKE 786,FMH(GP)
4640 POKE 251,FHL(1):POKE 252,FMH(1):2=TH:IF (CL=1) AND (25) THEN 2=5
4650 POKE 880,S:POKE 881,M:14=USR(0):IF PEEK(824)=0 THEN RETURN
4660 AS="(F2)0402Here is your*STR8(PEEK(824))* round shot group":84=84/PEEK(824)
4670 IF PEEK(823)>0 THEN AS=AS+"(F2)0903*STR8(PEEK(823))* shot(s) off screen"
4680 AS=AS+"(F2)1404*STR8(1+50)* meters"
4690 GOSUB 3250:POKE 53265,43:RETURN
4700 IF M=0 THEN RETURN
4710 11=0:12=PB*20:13=PEEK(838)-1:14=0:POKE 785,FHL(GP):POKE 786,FMH(GP)
4720 AS=AS+"(F2)1303(GRM)Hit:(F2)2199(RED)Misses:(YEL)(F2)2999No Fires(F8)(F8)":GOSUB 3300:11=0:12=0:13=0
4730 AD=11+PB*160:FOR I=1 TO 6:POKE 251,FHL(AD):POKE 252,FMH(AD)
4740 POKE 881,M:POKE 880,120+I
4750 14=14+USR(0):AS="(LBU)(F2)0599*STR8(1+50)* m":12=PB*3:DAV(1,5+8)=PEEK(910)
4760 DAV(1,6+2)=PEEK(911):DAV(1,7+2)=DAV(1,8)=PEEK(824)
4770 IF DAV(1,7+2)<0 THEN DAV(1,7+2)=0
4780 11=11+PEEK(910):12=12+PEEK(911):13=13+DAV(1,7+2)
4790 AS=AS+"(GRM)(F2)1399*STR8(PEEK(910))* (RED)(F2)2299*STR8(PEEK(911))* (YEL)(F2)3299"
4800 AS=AS+STR8(DAV(1,7+2))* (F8)(F8)":GOSUB 3300:NEXT I:14=14+M
4810 AS="(F2)0699(LBU)TOTAL(F2)1399(GRM)*STR8(11+)*(F2)2299(RED)*STR8(12+)*(F2)3299(YEL)*STR8(13+)*(F8)(F8)"
4820 AS=AS+"(LBU)(F2)0699Penalties*STR8(PEEK(912))* (F8)"
4830 13=9:GOSUB 3300:AS=AS+"(LBU)(F2)0699shot location: *RIGHTS(CR8,LEN(CR8)-5)* (F8)"
4840 89="(F2)1499(GRM)Standard met(LGRM):IF 11<15 THEN 89="(F2)1299(RED)Standard not met(LGRM)"
4850 AS=AS+89:GOSUB 3250:RETURN
4860 AD=FWH(76):TH=PEEK(AD+3):11=DAV(TH,6)
4870 X=(INT(RND(1)*65)+1)*2+71:POKE AD+1,X:Y=PEEK(AD+2):Y3=PEEK(AD+11)
4880 T3=T3+(T3>127)+256:IF TH=1 THEN POKE AD+15,X+48
4890 S=((TH-1)*NT)+21:POKE 838,S:AD=11+8*8:POKE AD+7,I
4900 POKE 900,255:POKE AD,255:GOSUB 3950
4910 AS="L=STR8(CL)*IT=STR8(1)*R=STR8(RP):GOSUB 5370:POKE 12+7*8,B,RP
4920 89=0:12=IR:GOSUB 5710:POKE 878,0
4930 11=(PEEK(900)<120):IF 11<128 THEN DAV(TH,6)=DAV(TH,6)+1
4940 IF 2>63 THEN RETURN
4950 FOR S=1 TO 5:H4(2)=0:NEXT 2:M=FWH(907):N=M+(M>128)*(M-128):GOSUB 3000
4960 J=0:GOSUB 3090:AS="(F3)03(CLR)(F5)00(F1)(WHT)steady pos*CR8:H4(2)=H4(2)+1:11=2
4970 28=MID$(CR8,6,1):J=1:GOSUB 3090:AS=AS+"(WHT)aiming*216=CR8:H4(2)=H4(2)+1
4980 12=2:CR8="(F2)3099*28+*check":IF 11>2 THEN CR8="(F2)3699*28+*ok"
4990 89="(WHT)breath con*CR8:J=2:GOSUB 3090:89=89+"(WHT)trigger sq*CR8
5000 H4(2)=H4(2)+1:J=3:GOSUB 3090:IF 11=0 THEN CR8="(F2)3299(RED)miss"
5005 CR8="(F1)(F2)0008(LBU)shot too*CR8:H4(2)=H4(2)+1:Y1=2
5006 IF (X1>3) AND (X2>3) AND (Y1>3) AND (11=0) THEN 216=CR8(3):SD(1,8)=CR(1+PB*4,2)
5010 AS=AS+11+89:GOSUB 3280:IF (H4(1)=0) AND (2>2) AND (11) THEN 5040
5020 GOSUB 4050:IF 2=128 THEN RETURN
5030 IF 1<>NT=6 THEN GOSUB 3310
5040 IF 11 THEN DAV(TH,5)=DAV(TH,5)+1
5050 RETURN
5060 FOR J=0 TO 3:SD(J,25)=SD(J,25)/3:NEXT J
5070 A=2:B=2:S=25:J=0:GOSUB 3090:AS="(F3)03(F6)00(F5)00(F7)00(CLR)(WHT)(F1)steady pos*CR8:11=2
5080 28=MID$(CR8,6,1):J=1:GOSUB 3090:AS=AS+"(WHT)aiming*CR8
5091 CR8="(F2)3099*28+*check":IF 11>2 THEN CR8="(F2)3699*28+*ok"
5093 AS=AS+"(WHT)breath con*CR8
5095 J=2:GOSUB 3090:AS=AS+"(WHT)trigger sq*CR8:J=3:GOSUB 3090
5100 S=A:1=8:GOSUB 3300:POKE 785,FHL(GP):POKE 786,FMH(GP):POKE 251,FHL(1)
5110 POKE 252,FMH(1):POKE 880,S:POKE 881,3:1=USR(0):AS=""
5120 IF PEEK(823)>0 THEN AS="(BLK)(F2)0921*STR8(PEEK(823))* shot(s) off screen"
5130 POKE 823,8:POKE 824,15:POKE 253,13:SYS CO:AS=AS+"(SWLC)(LGRM)":GOSUB 3250
5140 POKE 53265,43:RETURN
5150 AS=AS+"(F2)1303(GRM)Hit:(F2)2199(RED)Misses:(YEL)(F2)2999No Fires(F8)(F8)":GOSUB 3300
5170 POKE 785,FHL(GP):POKE 786,FMH(GP):11=0:12=0:13=0:14=0
5180 FOR I=1 TO 6:POKE 251,FHL(1):POKE 252,FMH(1):POKE 881,PEEK(838)
5190 POKE 880,120+1:14=14+USR(0):AS="(LBU)(F2)0599*STR8(1+50)* m"
5200 11=11+PEEK(910):12=12+PEEK(911):13=DAV(1,4)=PEEK(824):IF 13<0 THEN 23=0
5210 11=11+3:AS=AS+"(GRM)(F2)1399*STR8(PEEK(910))* (RED)(F2)2299*STR8(PEEK(911))
5220 AS=AS+"(YEL)(F2)3299*STR8(12+)*(F8)(F8)":GOSUB 3300:NEXT I:14=14+M
5230 AS="(F2)0699(LBU)TOTAL(F2)1399(GRM)*STR8(11+)*(F2)2299(RED)*STR8(12+)*(F2)3299(YEL)*STR8(13+)*(F8)(F8)"
5240 GOSUB 5620:AS=AS+CR8:GOSUB 3250:RETURN
5250 AS="(F3)09(F6)00(F5)00(F7)00(CLR)(RED)(SWLC)(F1)(F2)03024 Fundamentals of(F2)0203rifle marksmanship"
5260 AS=AS+"(GRM)(F2)0109(F1). (F1)Steady Position(F2)0112(F1). (F1)Aiming(F2)0115(F1). (F1)Breath Control"
5270 AS=AS+"(F2)0118(F1). (F1)Trigger Squeeze(F1)(LGRM)":GOSUB 3250:RETURN
5280 AS="(F3)09(F6)00(F5)00(F7)00(CLR)(RED)(SWLC)(F1)(F2)0407You did not meet(F2)0710the standard."
5290 AS=AS+"(F2)0213Prepare to refire.(F1)(LGRM)(F2)0823Full trigger to begin(F3)00":BC=2
5340 GOSUB 3300:GOSUB 3260:RETURN
5350 AS="(F3)03(F6)00(F5)00(F7)00(CLR)(GRM)(SWLC)(F1)(F2)0709Standard met.(F2)1113Continue.(F3)00":GOSUB 3300
5360 FOR S=1 TO 800:NEXT S:RETURN
5370 89="(IF (11 AND 7)*5)=0 THEN 5600
5380 89=STR8((11 AND 224)/32)+1)
5390 89="(F2)2400M*STR8((11 AND 7)*5)* (F4)0*RIGHT$(89,1)
5400 AS="(HOME)(BLK)(RVOM)(SWLC)*AS+89*(F6)0*CR8(BC+48):GOSUB 3300:RETURN
5410 AS=AS+"(C/LP)(C/LP)(C/LP)(C/LP)(C/LP)":GOSUB 3300:89=""
5420 GZT AS:IF AS="" THEN 5620
5430 IF (AS=CR8(13)) OR (LEN(89)>3) THEN AS="(C/UP)(F8)":GOSUB 3300:AS=89:RETURN
5440 IF AS<>CR8(20) THEN 5670
5450 IF 89<>"" THEN 89=LEFT$(89,LEN(89)-1):AS="(C/LP)(C/LP)(C/LP)(C/LP)":GOSUB 3300
5460 GOTO 5620
5470 IF (AS<0) OR (AS>2) THEN 5620
5475 IF (AS>="a") AND (AS<="z") THEN AS=CR8(ASC(AS) OR 128)
5480 89=89+AS:AS=AS+"(C/LP)":GOSUB 3300:GOTO 5620
5490 FOR S=12 TO 12+343 STEP 8:POKE S,255:NEXT S:RETURN
5700 POKE 49160,89:SYS 49162:RETURN
5710 POKE 785,10:POKE 786,192:POKE 49160,89:1=USR(2):RETURN

```

```

5720 POKE 251,1:SB=12:GOSUB 5700:AS="" :GOSUB 3250:POKE V+21,0
5730 S1=32768:S2=7:GOSUB 3310:GOSUB 3260:RETURN
5740 IF W1=0 THEN RETURN
5750 AS=STR$(W1 AND 7)+S1:BS=STR$(INT(W1/32)+1):B6="0"+RIGHT$(BS,1)
5760 AS="(F3)09(F5)13(F7)00(CLR)(BLK)(F1)(F2)0601WIND:"+AS+" mph (F4)" +B6:B6="(F2)0705offset needed"
5770 S=INT(W1/32):IF (S<0) AND (S<4) THEN 5800
5780 BS="(F2)0204(wind towards you)":IF S=0 THEN BS="(F2)0004(wind away from you)"
5790 BS=BS+(F2)0407No offset needed"
5800 AS=AS+BS+(F1)(F2)311300 M(F2)1913150 M(F2)071550 M":GOSUB 3300
5810 POKE 251,2:SB=12:GOSUB 5700:AS=""(BLK)":GOSUB 3250:POKE V+21,0:RETURN
5820 CR6="(F2)1799(GRM)Expert":IF H1<36 THEN CR6="(F2)1699(LGRN)Sharpshooter"
5830 IF H1<30 THEN CR6="(F2)1699(YELO)Marksmen"
5840 IF H1<23 THEN CR6="(F2)1499(RED)Unqualified"
5850 IF (H4(0)-1)AND(H1>22) THEN CR6=" (YELO)Marksmen (because you had to refire)"
5860 RETURN
6000 REM THE FOLLOWING IS THE CRITERION FOR GOOD,AVERAGE,BELOW AVERAGE,POOR
6010 DATA 2.5,5,8,10.5:REM SP SUP
6020 DATA 1.6,3,5,6.5,9:REM AIM SUP
6030 DATA 2.5,5,8,10.5:REM TS SUP
6040 DATA 1.6,3,5,6.5,9:REM SL SUP
6050 DATA 4.6,5,9,5,12:REM SV UNS
6060 DATA 2.4,5,8,11:REM AIM UNS
6070 DATA 4.7,11,14.5:REM TS UNS
6080 DATA 2.4,5,8,11:REM SL UNS
6090 DATA 39,35,30,26:REM HITS
6100 DATA 1.5,3,5,6.5,9:REM ACCURACY
6110 DATA 3.2,47,34,3.4,5,23,37,9,4,6,11,13,9
6120 DATA 4.4,11,15,6,3,2,11,15,7,2,1,11,16,6
6130 DATA "(F2)3299(RED)poor","(F2)2299(ORNG)below avg","(F2)2699(YELO)average","(F2)5299(LGRN)good"
6140 DATA "(F2)2299(GRM)excellent"

```



```

6:TIME LIMIT*2 (SECONDS)
7:DELAY (FOR DLSTR,CDLSTR)
8:INCREMENT (FOR INSTR)
9:TIME/FLIGHT (PIXELS/BYTES)
10:X DRIFT
11:Y DRIFT
12:BIT 7:NOT A TARGET
    6:REVERSE DIRECTION
    5:TAR MORE THAN 1 SPR
    4:DON'T INC TARPARE
    2-0:0 TARGETS
13:X CENTER OF MASS OFFSET/2
14:Y CENTER OF MASS OFFSET

;INFO IS SAVED AS FOLLOWS:
;BYTE 0:TARGET # (FOR ID)
;1:BULLET X/2
;2:BULLET Y
;3:TARGET X/2
;4:TARGET Y
;5:NUMB20 (LOW)
;6:NUMB20 (HIGH)
START LDA #4
BIT 53273
BEQ CONTIN
LDA 53273
STA 53273
JMP 8F8BC
CONTIN LDA 53265
AND 0127
STA 53265
LDA 0250
STA 53264
LDA 53273
STA 53273
LDA IRQ2
AND 01
BEQ IRQ010
JMP REPLAY
IRQ010 LDX V+30 ;SPR/SPR
LDY V+31 ;SPRITE/DATA
LDA IRQ
AND 032 ;COLLISION
BEQ IRQ020
STX SSCOL
STY SDCOL
LDA IRQ ;CLEAR
AND 0223 ;COLLISION
STA IRQ ;FLAG
IRQ020 LDA IRQ
AND 016
BEQ IRQ030
;PLAY ANY SOUNDS HERE
IRQ030 LDA IRQ ;WAITING FOR
AND 08 ;TRIGGER
BEQ IRQ040 ;RELEASE?
LDA 56321 ;YES:HAS IT
CMP 0247 ;BEEN
BEQ IRQ040 ;RELEASED
LDA IRQ ;YES:CLEAR
AND 0247 ;FLAG
STA IRQ
IRQ040 LDA CRSDLA ;CROSS ON?
BEQ IRQ060
DEC CRSDLA
BNE IRQ060
LDA HITSFR ;TURN OFF
EOR 0255 ;CROSS AND
AND V+21 ;ANY HIT
STA V+21 ;TARGET LEFT
BIT IRQ2
BVC IRQ050
CMP 00
BNE IRQ050
LDA IRQ
AND 063
STA IRQ
JMP 8EA31 ;NORMAL IRQ
IRQ050 LDA #0
STA HITSFR
IRQ060 LDA IRQ ;TAKE ANY
AND 0192 ;READINGS?
BNE IRQ070
LDA #0
STA CUR1
STA CUR2
STA BORCOL
JMP 8EA31 ;NORMAL IRQ
;SAVE
;SPR AND SFC
PHA
PHA
DEC HAFSEC ;NEW TARGET?
BEQ IRQ080 ;OR TIME LM?
JMP IRQ250 ;NOT TIME YET
IRQ080 LDA #0 ;RESTORE
STA HAFSEC ;HALF SECOND
MOVE SFB,TARORD
LDY 0255

LDA IRQ ;IS TARGET
AND 02 ;CHECK
BNE IRQ140 ;DISABLED?
LDY #0
LDA (SFB).Y ;0 TARGETS
CMP 0255
BNE IRQ100
LDA 032
STA PSTAT
DINC TARORD
LDA IRQ ;DON'T TAKE
AND 063 ;ANY MORE
STA IRQ ;READINGS IF
JMP IRQ140 ;NO TARGETS
IRQ100 CMP 0234
BNE IRQ110
LDA IRQ
ORA 02
STA IRQ
JMP IRQ140
IRQ110 CMP 0233 ;WHISTLE?
BNE IRQ130
LDA OFFSCR ;SET FLAG
ORA 01
STA OFFSCR
IRQ120 DINC SFB
JMP IRQ090
IRQ130 CMP 0128 ;DELAY
BCC IRQ150
BSC 01
STA (SFB).Y
CMP 0128
BEQ IRQ120
DEY
IRQ140 LDA #0
IRQ150 STA H3IRQ ;TARGETS
LDX #7
LDA 0128
STA H3IRQ ;SPRITE BIT
IRQ160 LDA H3IRQ
EOR 0255 ;NOT SPRITE
STA H4IRQ ;BIT
LDA V+21
AND H3IRQ
BEQ IRQ180 ;SPRITE OFF
LDA JIFFTS,X
BNI IRQ170 ;NO LIMIT
DEC JIFFTS,X
BNE IRQ170 ;MORE TIME
LDA H3IRQ ;TIME LIMIT
ORA OFFSCR ;HAS EXPIRED
STA OFFSCR
LDA 0128
JIFFTS,X
OFFSCR ;HAS TIME
EOR 0255 ;EXP IRED
AND V+21 ;ON ALL
BNE IRQ170 ;TARGETS?
LDA 064
STA PSTAT
IRQ170 JMP IRQ230
IRQ180 LDA H3IRQ ;ANY TAR NEED
BEQ IRQ170 ;DISPLAYING?
LDA H3IRQ ;ONE LESS TAR
AND V+23 ;CLEAR
STA V+23 ;EXPAND Y
LDA H4IRQ ;CLEAR
AND V+29 ;EXPAND X
STA V+29
LDA H4IRQ ;CLEAR
AND V+16 ;RIGHT X
STA V+16
TXA
ASL A
TXA
LDA (SFB).Y ;X COORDINATE
STA V,X
INY
LDA (SFB).Y ;Y COORDINATE
STA V+1,X
INY
TXA
LSR A
TXA
LDA (SFB).Y
STA TARUM,X
INY
LDA (SFB).Y ;SPRITE PTR
STA 2040,X
INY
LDA (SFB).Y ;EXPAND X?
BPL IRQ190
LDA V+29 ;YES
ORA H3IRQ
STA V+29
IRQ190 LDA (SFB).Y ;EXPAND Y?

AND 064
BEQ IRQ200
LDA V+23 ;YES?
ORA H3IRQ
STA V+23
IRQ200 LDA (SFB).Y ;RIGHT X?
AND 032
BEQ IRQ210
LDA V+16
ORA H3IRQ
STA V+16
IRQ210 LDA (SFB).Y ;SPRITE COLOR
AND 015
STA V+39,X
INY
LDA (SFB).Y ;TIME LIMIT
STA JIFFTS,X
INY
LDA (SFB).Y ;DELAY FOR
STA DLSTR,X ;MOVEMENT
STA CDLSTR,X
INY
LDA (SFB).Y ;INCREMENTFOR
STA INSTR,X ;MOVEMENT
INY
LDA (SFB).Y ;TIME OF
STA TIMEFL,X ;FLIGHT
INY
LDA (SFB).Y ;X DRIFT
STA XDRIPT,X
INY
LDA (SFB).Y
STA YDRIPT,X
INY
LDA (SFB).Y ;SPECIAL
STA SPECIL,X
AND 016 ;COUNT AS
BNE IRQ220 ;TARPARE
INC TARPARE
TXA
JSR INCMUM
TAX
IRQ220 INY
LDA (SFB).Y ;CEN X OFFSET
STA CENX,X
INY
LDA (SFB).Y ;CEN Y OFFSET
STA CENY,X
INY
LDA V+21 ;TURN ON
ORA H3IRQ ;SPRITE
STA V+21
IRQ230 LSR H3IRQ
DEX
BEQ IRQ240 ;FINISHED?
JMP IRQ160
IRQ240 TYA
CLC
ADC SFB ;FOR NEXT
STA TARORD ;TIME
ADC 00
STA TARORD+1
LDA IRQ2 ;SHOW TARGET?
AND 02 ;NUMBER?
BEQ IRQ250
JSR SHOWUM
IRQ250 INY
BNI BEFORE
JMP AFTER
BEFORE AND 05 ;READY TO
BEQ IRQ270 ;PROCESS?
IRQ260 JMP IRQ340
IRQ270 JSR CMSCRM
ADDA SFB,XLPB20
LDA CUR2
AND 0127
TXA
LDA 8BOTS
AND 01
BEQ IRQ280
TXA
ORA 0128
TXA
INC SFC
IRQ280 LDA H3IRQ
STA XLPB60,Y
LDA H2IRQ
STA YLPB60,Y
INY
STY CUR2
DINC NUMB60
DEC H7IRQ
BNE IRQ260
LDA #3
STA H7IRQ
LDY CUR1
LDA H1IRQ
STA (SFB).Y

```

```

INC 8FC
INC 8FC
LDA H2IRQ
STA (8FB).Y
INX
STY CUR1
DIFC MUMR20
LDY CURJRT
INC CURSRT
CPY 05
BCC IRQ290
LDY 00
STY CURSRT
IRQ290 LDA H1IRQ
STA RTBUF.Y
TAX
CLC
ADC 05
TAX
LDA H2IRQ
STA RTBUF.Y
LDA IRQ ;HAS TRIGGER
AND 012 ;DEEN
BNE IRQ300 ;RELEASED?
LDA 56321 ;TRIGR PULL
CMP 0247
BNE IRQ300
BIT BORCOL ;LIGHTPEN
BPL SMPULL ;ON SCREEN?
LDA 04
STA 53280
IRQ300 JMP IRQ340
SMPULL JSR BANG
LDA 00 ;IF ANYONE
STA XVAL ;HAS THE
STA XVAL+1 ;PEVELATION
STA YVAL ;THAT SORT-
STA YVAL+1 ;ING REALLY
LDA H1IRQ ;IS THE
BEQ IRQ320 ;ANSWER,
ASL A ;REMOVE
LDX 00 ;THESE 25
BCC IRQ310 ;4 REINSERT
INX ;THE CALL TO
IRQ310 CLC ;CTRMV
ADC OFFX ;---
STA XVAL ;---
TXA ;---
ADC OFFX+1 ;---
STA XVAL+1 ;---
LDA H2IRQ ;---
CLC ;---
ADC OFFY ;---
STA YVAL ;---
IRQ320 LDA IRQ
AND 0127
ORA 076
STA IRQ ;FORMERLY 3
LDA 00
STA SORTAF
LDA 010
STA MUMRD
JSR INFOFB
LDY 05
LDA MUMR20
STA (8FB).Y
STA LASTSH.Y
INX
LDA MUMR20+1
STA (8FB).Y
STA LASTSH.Y
LDA MUMR60
SEC
BNC 01
STA LASTSH+7
LDA MUMR60+1
BNC 00
STA LASTSH+8
LDA 00
STA CUR1
STA CUR2
STA MUMR20
STA MUMR20+1
STA MUMR60
STA MUMR60+1
IRQ340 PLA
STA 8FC
PLA
STA 8FB
JMP 8E431 ;NORMAL IRQ
LDY CUR2 ;STACK PTR
INC CUR2
LDA 53267 ;X LOCATION
STA H1IRQ
STA XLP60.Y
LDA 53268 ;Y LOCATION
STA H2IRQ
STA YLP60.Y
LDA SORTAF
BEQ IRQ360
LDY CURSRT
INC
LPT
BCC
LDY
STY CURSRT
H1IRQ
RTBUF.Y
TAX
CLC
ADC 05
TAX
LDA H2IRQ
STA RTBUF.Y
LDA 00 ;ZERO STACK
STA CUR1 ;PTR IF DONE
STA CUR2
STA CURSRT
LDA 01
STA H2IRQ
BIT IRQ2
BIT IRQ370
BVC IRQ380
LDA V+21
LDA 0234
AND IRQ380
BNE
IRQ370 LDA IRQ
AND 063
STA IRQ
IRQ380 JMP IRQ340
ONSCRN LDA 53267 ;X READINGS
LDA H1IRQ
LDX 53268 ;Y READINGS
STX H2IRQ
CMP LPCHPX
BNE ONSC30
CPX LPCHPY
BNE ONSC30
BIT BORCOL
BNI ONSC20
INC BORCOL
LDA BORCOL
CMP 030
BCS ONSC10
RTS
ONSC10 LDA 53280
ORA 0128
STA BORCOL
ONSC20 LDA 00
STA H1IRQ
STA H2IRQ
ONSC20 RTS
ONSC30 STA LPCHPX
STX LPCHPY
BIT BORCOL
BPL ONSC40
LDA BORCOL
STA 53280
ONSC40 LDA 00
STA BORCOL
RTS
INFOFB LDA 00
STA 8FC
LDA SHOTS
ASL A
ASL A
ASL A
ROL 8FC
CLC
ADC 0<INFO
STA 8FB
LDA 8FC
ADC 0>INFO
STA 8FC
RTS
INCMUM LDX CUMUM+1
INX
CPX 010
BCC INC02G
LDX CUMUM
INX
CPX 010
BCC INC010
LDX 00
INC010 STX CUMUM
LDX 00
INC02G STX CUMUM+1
RTS
SHOVUM LDX 00
LDX 00 ;LEAD SPACE
LDA CUMUM
BEQ SHN010
ASL A
ASL A
ASL A
TAX
SHN010 LDA MUMDAT.X
STA 4236.Y
INX
INX
CPY 016
BCC SHN020
RTS
MUMDAT .BYTE
193,183,143,137,153,153,195,255,231,231,19
9,231,231,231,129
.BYTE
251,195,153,249,243,207,159,129,255,195,15
3,249,227,249,153
.BYTE
195,255,249,241,225,153,129,249,249,255,12
9,159,131,249,249
.BYTE
153,195,255,195,153,159,131,153,153,195,25
5,129,153,243,231
.BYTE
231,231,231,255,195,153,153,195,153,153,19
5,255,195,153,153
.BYTE
193,249,153,195,255,255,255,255,255,255,25
5,255,255
.END
.LTB REPLAY
;REPLAY FLA BWM CARTRIDGE
REPLAY DEC H7IRQ
BEQ RPL010
JMP RPL090
RPL010 LDA 03
STA H7IRQ
LDY CUR1
INX
CPY STOP ;LAST RDC?
BNE RPL020
LDA YVAL
BEQ RPL050
SEC
SBC TRAJ
STA H6IRQ
LDA XVAL
BEQ RPL050
SEC
SBC WDRIPT
TAX
LDA XVAL+1
SBC WDRIPT+1
STA H5IRQ
TXA
LDX H5IRQ
DEY
JMP RPL040
RPL020 DEY
LDA 14848.Y ;BULY
BEQ RPL050
CLC
ADC OFFY
STA H6IRQ
LDX 00
LDA 14592.Y ;BULX
BEQ RPL050
ASL A
BCC RPL030
LDX 01
RPL030 CLC
ADC OFFX
STA H4IRQ
TXA
ADC OFFX+1
STA H3IRQ
LDA H4IRQ
RPL040 SEC
SBC H1IRQ ;TARX L
STA H4IRQ ;BULK-TARX
LDA H5IRQ
SBC H2IRQ ;TARX H
STA H5IRQ
LDA H4IRQ
CLC
ADC 0231 ;254-23 SPOST
STA V+2 ;OFFSET
LDA H5IRQ

```

```

ADC #0
BNE RPL040
LDA V+16
AND #253
STA V+16
JMP RPL070
RPL050 LDA #0
STA V+2
STA V+3
LDA V+16
AND #253
STA V+16
JMP RPL080
RPL060 LDA V+16
ORA #2
STA V+16
RPL070 LDA HIRQ ;BULY
SEC
SBC HIRQ ;BULY-TARY
CLC
ADC #175 ;200-25 SPOST
STA V+3 ;OFFSET
RPL080 INY
STY CTR1
CPY STOP
BNE RPL090
LDA #0
STA IRQ2
RPL090 JMP #EA31 ;NORMAL IRQ
END

;PROCEDURE ROTATE
;TAKES READINGS BEFORE TRIGGER
;PULL AND MOVES THEM SO THAT
;THE OLDEST READINGS ARE FIRST.
;C:SYS ROTATE
;A:RDGS IN BUFFERS ARE ADJUSTED.
ROTATE LDA 1
PHA
LDA #54
STA 1
LDA LASTSH+6
BEQ ROT030
LDY LASTSH+5
BEQ ROT030
ADDR #FB,XLPB20
ADDR #FD,YLPB20
LDY #0
LDA SHOTS
AND #1
BNE ROT010
INC #FC
INC #FE
ROT010 LDA (FB),Y
STA HLDBUF,X
LDA (FD),Y
STA HLDBUF+256,X
INY
INX
BNE ROT010
LDY #0
ROT020 LDA HLDBUF,Y
STA (FB),Y
LDA HLDBUF+256,Y
STA (FD),Y
INY
BNE ROT020
LDA LASTSH+7
ASL A
BEQ ROT070
LCA LASTSH+8
BNE ROT040
BCC ROT040
ROT040 LDA #CALP860
STA #FB
STA #FD
LDA #>XLPB60
STA #FC
STA #FE
INC #FE
LDA LASTSH+7
AND #127
TAY
LDA SHOTS
AND #1
BEQ ROT050
LDA #FB
CLC
ADC #128
STA #FB
STA #FD
LDA #FC
ADC #0
STA #FC
STA #FE
INC #FE
ROT050 LDA (FB),Y
STA HLDBUF,X
LDA (FD),Y

```

```

STA HLDBUF+128,X
INY
TAY
AND #127
TAY
INX
BPL ROT050
LDY #0
ROT060 LDA HLDBUF,Y
STA (FB),Y
LDA HLDBUF+128,Y
STA (FD),Y
INY
BPL ROT060
ROT070 PLA
STA 1
RTS
NOTTRG LDA #6321 ;REPEAT
CMP #255 ;UNTIL
BNE NOTTRG ;TRIGGER IS
RTS ;RELEASED
BANG LDA #15
STA #4296
LDA #10
STA #4277
LDA #30
STA #4273
LDA #128
STA #427C
LDA #129
STA #4276
RTS
WHISL1 LDY #23
LDA #0
WHISL1 STA SID,Y
DEY
BPL WHISL10
LDA #18
STA DELAY
WHISL20 LDA #180
STA SID+1
LDA #46
STA SID
LDA #15
STA SID+5
STA SID+24
LDY #7
WHISL30 LDX #255
WHISL40 DEX
BNE WHISL40
DEY
BNE WHISL30
LDA #170
STA SID+1
LDA #46
STA SID
LDA #21
STA SID+4
LDY #30
LDY #255
WHISL50 DEX
WHISL60 DEX
BNE WHISL60
DEY
BNE WHISL50
DEC DELAY
BNE WHISL20
LDY #23
LDA #0
WHISL70 STA SID,Y
DEY
BPL WHISL70
RTS

;PROCEDURE WAIT
;CAUSES A DELAY
;B:LDY WITH AN APPROPRIATE DELAY
;C:JBR WAIT
;A:HOME
WAIT LDX #255
WAIT1 DEX
BNE WAIT1
DEY
BNE WAIT1
RTS
SCENE LDA #FB ;CH-- #/BANK
STA #CFFF
LDY #0
LDA (FB),Y
STA #FB ;CRUNCH CODE
DINC #FD
LDA #43
STA #3265
LDA #29
STY #3272
ADDR #A3,1024
SCL010 LDA (FB),Y
STA (A3),Y
DINC #FD
DINC #A3

```

```

LDA #A3
CMP #<1024
BNE SCL013
LDA #A4
CMP #>1024
BNE SCL010
ADDR #A3,8192
SCL020 LDA #FB ;CRUNCH CODE
STA (A3),Y
DINC #A3
LDA #A3
CMP #<16192
BNE SCL020
LDA #A4
CMP #>16192
BNE SCL020
ADDR #A3,8192
SCL030 LDA (FD),Y
CMP #FB ;CRUNCH CODE
BNE SCL040
DINC #FD
LDA (FD),Y
STA #A3
DINC #FD
LDA (FD),Y
CLC
ADC #>8192
STA #A4
JMP SCL050
SCL040 STA (A3),Y
DINC #A3
SCL050 DINC #FD
LDA #A3
CMP #<16192
BNE SCL030
LDA #A4
CMP #>16192
BNE SCL030
LDA #59
STA #3265
LDA #32
STA #DFFF ;RAM
RTS

;PROCEDURE SEVAL
;MOVE VALUES FROM UNDER ROM
;SINCE SHOTS WILL HAVE ALREADY
;BEEN INCREMENTED, THIS ROUTINE
;MOVES THE HIGH BUFFER IF SHOTS
;IS EVEN. IT MOVES THE LOW
;BUFFER IF SHOTS IS ODD
SEVAL LDA 1
PHA
LDA #54 ;SELECT RAM
STA 1 ;AT $A000
ADDR #FB,XLPB20
LDY #0
LDA SHOTS
AND #1
BNE SEER010
INC #FC
SEER010 LDA (FB),Y
STA #4592,Y
INY
BNE SEER010
INC #FC
INC #FC
SEER020 LDA (FB),Y
STA #4640,Y
INY
BNE SEER020
PLA
STA 1
RTS

;PROCEDURE COLORS
;CHANGES COLOR OF PART OF BITMAP
;POKE HOLD1 WITH START LINE
;POKE HOLD2 WITH # OF LINES
;POKE #FD WITH THE COLOR
COLORS ADDR #FB,1024
LDX HOLD1 ;START LINE
BEQ COL020
COL010 JBR ADD40
DEX
BNE COL010
COL020 LDX HOLD2 ;HOW MANY
COL030 LDY #39
COL040 LDA #FD ;COLOR
STA (FB),Y
DEY
BPL COL040
JBR ADD40
DEX
BNE COL030
RTS
ADD40 LDA #FB ;ADD 40 TO
CLC ;#FB FOR
ADC #40 ;NEXT LINE
STA #FB
LDA #FC

```

```

ADC #0
STA SFC
RTS
.LIB MATHFUNCTIONS
;MATHFUNCTIONS FOR BRM CARTRIDGE
MATH JSR UNFLOT
LDA 47
STA SFB
LDA 48
STA SFC
LDY #0
MAT010 LDA (SFB),Y
BNE MAT020
RTS
;NO SD ARRAY
MAT020 CMP #8
BNE MAT030
INY
LDA (SFB),Y
CMP #0
BEQ MAT040
MAT030 INY
LDA (SFB),Y
CLC
ADC SFB
TAX
INY
LDA (SFB),Y
ADC SFC
STX SFB
STA SFC
JMP MAT010
MAT040 LDA SFB
CLC
ADC #9
STA HOLDAD
LDA SFC
ADC #0
STA HOLDAD+1
LDX 101
BEQ MAT050
LDA HOLDAD
CLC
ADC #20
STA HOLDAD
LDA HOLDAD+1
ALC #0
STA HOLDAD+1
DEX
BNE MAT050
;STEADY POSITION SCORE
MAT060 LDA #128
STA HOLD
SEC
SBC SFB
CLC
ADC #1
CMP #2
BCS MAT070
LDA #255
TAY
JSR FLOAT
JMP MAT080
MAT070 PHA
JSR STDEV
LDX HOLDAD
LDY HOLDAD+1
JSR FALNEM
INC SFE
LDA SFB
STA NSIZE
LDA SFC
STA TIMES
LDA #0
STA HOLD
PLA
JSR STDEV
JSR FALFA2
LDA #<CONST
LDY #>CONST
JSR MEMFAL
JSR MULTPLY
JSR FALFA2
LDY HOLDAD+1
JSR MEMFAL
JSR ADD
LDA 162
AND #127
STA 102
JMP MAT110
MAT110 LDX HOLDAD
LDY HOLDAD+1
JSR FALNEM
;TRIGGER SQUEEZE SCORE
JSR NEXTAR
CMP SFB
BNE MAT120
LDA #255
TAY
JSR FLOAT
JMP MAT130
MAT120 JSR RANGE
LDA NSIZE

```

```

SBC SFB
CLC
ADC #1
CMP #2
BCS MAT090
LDA #255
TAY
JSR FLOAT
JMP MAT110
MAT090 STA NSIZE
JSR AVG
TAY
CLC
ADC OFFX
TAY
TAX
ADC OFFX+1
TAX
TAY
CLC
ADC WDRIFF
STA TEMP
TAX
ADC WDRIFF+1
STA TEMP+1
LDX #0
LDA LASTSH+3
ASL
BCC MAT100
INX
SEC
SBC TEMP
TAY
TAX
SBC TEMP+1
STY HOLD1
STA HOLD1+1
JSR FLOAT
JSR FALFA2
LDY HOLD1
LDA HOLD1+1
JSR FLOAT
JSR MULTPLY
LDX HOLDAD
LDY HOLDAD+1
JSR FALNEM
INC SFE
LDA #0
STA HOLD
JSR AVG
TAY
CLC
ADC OFFY
CLC
ADC TRAJ
STA TEMP+2
LDA LASTSH+4
SEC
SBC TEMP+2
TAY
LDA #0
SBC #0
STY HOLD1
STA HOLD1+1
JSR FLOAT
JSR FALFA2
LDY HOLD1
LDA HOLD1+1
JSR FLOAT
JSR MULTPLY
JSR FALFA2
LDA #<CONST
LDY #>CONST
JSR MEMFAL
JSR MULTPLY
JSR FALFA2
LDY HOLDAD+1
JSR MEMFAL
JSR ADD
LDA 162
AND #127
STA 102
JMP MAT110
MAT110 LDX HOLDAD
LDY HOLDAD+1
JSR FALNEM
;TRIGGER SQUEEZE SCORE
JSR NEXTAR
CMP SFB
BNE MAT120
LDA #255
TAY
JSR FLOAT
JMP MAT130
MAT120 JSR RANGE
LDA NSIZE

```

```

PHA
LDA TIMES
PHA
INC SFE
LDA #0
STA HOLD
JSR RANGE
ADDR SFD,YLFA60
LDA #0
STA SFB
LDA #2
STA SFC
JSR RAW010
JSR FALFA2
LDA #<CONST
LDY #>CONST
JSR MEMFAL
JSR MULTPLY
JSR FALFA2
PLA
STA TIMES
PLA
STA NSIZE
LDA #128
STA HOLD
ADDR SFD,XLFA60
JSR RAW010
JMP ADD
MAT130 LDX HOLDAD
LDY HOLDAD+1
JSR FALNEM
;SHOT LOCATION SCORE
LDA LASTSH
CMP #255
BNE MAT140
TAY
JSR FLOAT
JMP MAT150
MAT140 JSR NEXTAR
JSR RADERR
MAT150 LDX HOLDAD
LDY HOLDAD+1
JSR FALNEM
LDA TEMP
LSR
ROR A
LDY TEMP+2
JSR FLOAT
RTS
NEXTAR LDA HOLDAD
CLC
ADC #5
STA HOLDAD
LDA HOLDAD+1
ADC #0
STA HOLDAD+1
ADDR SFD,XLFA60
LDA SHOTS
AND #1
BNE NXA020
LDA SFD
CLC
ADC #128
STA SFD
LDA SFE
ADC #0
STA SFE
NXA020 LDA HOLDAD
LDY HOLDAD+1
JSR MEMFAL
JSR UNFLOT
LDA 100
STA SFB
STA NSIZE
LDA 101
STA SFC
STA TIMES
RTS
MUL2 LUX #0
BIT HOLD
BPL ML2010
ASL A
BCC ML2010
INX
ML2010 RTS
;CONSTANTS (AND CONSTANTS SQUARED)
;FOR SCALING THE Y COORDINATE
;(320/23.5)/(200/19.5)
;1.33 = 129,170,61,112,164
;1.76 = 129,225,71,174,20
;320/200
;1.6 = 129,76,204,204,305
;2.56 = 130,163,215,10,61
CONST .BYTE 129,76,204,204,205
CONST .BYTE 130,163,215,10,61
ADJLOC LDA 71
STA HOLDAD

```

```

LDA 72
STA HOLDAD+1
LDA 1
PHA
LDA 054
STA 1
LDY 023
ADJ010 LDA INFO.Y
STA TEMP.Y
DEY
BPL ADJ010
PLA
STA 1
LDX 00
ADJ020 STX MOLDX
LDA HOLDAD
LDY HOLDAD+1
JSR MEMFAL
JSR UNFLOT
LDA 100 ;X VALUE
ASL A
LDY 00
BCC ADJ030
INY
ADJ030 CLC
ADC OFFX
STA LASTSH+1 ;BULLET X
TYA
ADC OFFX+1
LSR A
ROR LASTSH+1
LDA 101 ;Y VALUE
CLC
ADC OFFY
STA LASTSH+2 ;BULLET Y
LDX MOLDX
LDA TEMP+3.X
STA LASTSH+3
LDA TEMP+4.X
STA LASTSH+4
JSR RADERR
LDX MOLDAD
LDY MOLDAD+1
JSR FAIHEM
LDA MOLDAD ;SET UP
CLC ;FOR
ADC 010 ;SHOT LOC
STA MOLDAD ;SCORE
LDA MOLDAD+1
ADC 00
STA MOLDAD+1
LDX MOLDX
LDA TEMP+1.X ;BULLET X
ASL A
LDY 00
BCC ADJ040
INY
ADJ040 CLC
ADC OFFX
STA TEMP+1.X
TYA
ADC OFFX+1
LSR A
ROR TEMP+1.X
LDA TEMP+1.X
STA INFO+1.X
STA INFO+1.X
STA LASTSH+1
LDA TEMP+2.X ;BULLET Y
CLC
ADC OFFY
STA INFO+2.X
STA INFO+2.X
STA LASTSH+2
JSR RADERR
LDX MOLDAD
LDY MOLDAD+1
JSR FAIHEM
LDA MOLDAD ;SET UP
CLC ;FOR NEXT
ADC 010 ;AIMING
STA MOLDAD ;SCORE
LDA MOLDAD+1
ADC 00
STA MOLDAD+1
LDA MOLDX
CLC
ADC 00
STA MOLDX
CMP 024
BCS ADJ050
JMP ADJ020
ADJ050 RTS
SIDEV PHA
LDA 00
TAY
JSR FLOAT
JSR FA15C
LDA 00

```

```

STA SUMX
STA SUMX+1
STA MOLD3
STA MOLD4
STDL10 LDA 1
PHA
LDA 054
STA 1
LDY TIMES
LDA (8FD).Y
TAX
BIT MOLD4
BMI STDL20
STA MOLD3
LDA 0128
STA MOLD4
TXA
CMP MOLD3
STDL20 BREQ STDL30
LDA MOLD4
ORA 064
STA MOLD4
TXA
STDL30 JSR MUL2
STA MOLD1
STX MOLD2
CLC
ADC SUMX
STA SUMX
LDA SUMX+1
ADC MOLD2
STA SUMX+1
PLA
STA 1
LDY MOLD1
LDA MOLD2
JSR FLOAT
JSR FA1FA2
LDY MOLD1
LDA MOLD2
JSR FLOAT
JSR MULTPLY
LDA 055C
LDY 00
JSR MEMFA2
JSR ADD
JSR FA15C
DEC TIMES
LDY TIMES
BMI STDL40
CPY MSIZE
BCS STDL10
STDL40 PLA
STA MSIZE
BIT MOLD4
BVC STDL50
LDA 00
TAY
JSR FLOAT
RTS
STDL50 LDY SUMX
LDA SUMX+1
JSR FLOAT
JSR FA1FA2
LDY SUMX
LDA SUMX+1
JSR FLOAT
JSR MULTPLY
JSR FA1FA2
LDA 00
LDY MSIZE
JSR FLOAT
JSR DIVIDE
LDA 055C
LDY 00
JSR MEMFA2
JSR SUBTRT
JSR FA1FA2
LDA 00
LDY MSIZE
JSR FLOAT
JSR DIVIDE
LDA 102 ;FA1 STON
AND 0127
STA 104 ;ASS
JSR SQRT
RTS
AVG LDA 00
STA SUMX
STA SUMX+1
STA MOLD1
STA MOLD1+1
LDA 1
PHA
LDA 054
STA 1
LDY 0FC
AVG010 LDA (8FD).Y

```

```

JSR MUL2
CLC
ADC SUMX
STA SUMX
TXA
ADC SUMX+1
STA SUMX+1
DBY
BMI AVG020
CPY 0FB
BCS AVG010
AVG020 PLA
STA 1
AVG030 LDA SUMX+1
BNE AVG040
LDA MSIZE
CMP SUMX
BCC AVG040
BNE AVG030
AVG040 LDA SUMX
SEC
BSC MSIZE
STA SUMX
LDA SUMX+1
BSC 00
STA SUMX+1
DINC MOLD1
JMP AVG030
AVG050 LDY MOLD1
LDX MOLD1+1
RTS
RANGE LDA 00
STA MSIZE
LDA 0255
STA TIMES
LDA 1
PHA
LDA 054
STA 1
LDY 0FC
RAN020 LDA (8FD).Y
CMP TIMES
BCS RAN030
STA TIMES
RAN030 CMP MSIZE
BCC RAN040
STA MSIZE
RAN040 DEY
BMI RAN050
CPY 0FB
BCS RAN020
RAN050 PLA
STA 1
LDA MSIZE
SEC
BSC TIMES
JSR MUL2
TAY
TXA
JSR FLOAT
RTS
RADERR LDX 00
LDA LASTSH+1 ;BULLET X
ASL A
BCC RAD010
INX
RAD010 STA CODE3
STX CODE4
LDX 00
LDA LASTSH+3 ;TARGET X
ASL A
BCC RAD020
INX
RAD020 SEC
BSC CODE3
STA CODE3
TXA
BSC CODE4
STA CODE4
LDY CODE3
JSR FLOAT
JSR FA1FA2
LDY CODE3
LDA CODE4
JSR FLOAT
JSR MULTPLY
JSR FA15C
LDX 00
LDA LASTSH+2 ;BULLET Y
SEC
BSC LASTSH+4 ;TARGET Y
BCS RAD030
DEX
RAD030 STA CODE3
STX CODE4
LDY CODE3
LDA CODE4
JSR FLOAT
JSR FA1FA2

```

```

LDY CODE3
LDA CODE4
JSR FLOAT
JSR MULTPLY
JSR PAI1A2
LDA <<CONS0
LDY <>CONS0
JSR MEMF1A1
JSR MULTPLY
LDA #33C
LDY #0
JSR MEMF1A2
JSR ADD
LDA 102 ;VAL SIGN
AND #127
STA 102 ;ABS
JSR SQRT
RTS
.END
;LTS SHOTGROUPS
;SHOTGROUPS IN BRM.3400.TXT
;PROCEDURE EXPTAR
;POKE HOLD3,TAR# THE CENTER OF
;THE TARGET IS PLACED AT 140,100
;IF THE CENTER OF MASS OFFSETS
;ARE CHANGED AGAIN, A NEW START
;MUST BE CALCULATED AS:
;(166-OFF*FACTOR,100-OFF*FACTOR).
;EXPDATA IS SPRITE POINTER.
;STARTX,STARTY,FACTOR.
EXPTAR LDA #0
STA EVAL+1
STA #3D
STA CHOICE
LDA HOLD3
AND #127
SEC
SBC #1
ASL A
ASL A
TAY
LDA EXPDAT+1,Y
STA XVAL
STA HOLDX
LDA EXPDAT+2,Y
STA YVAL
LDA EXPDAT+3,Y
STA CODE2
LDA EXPDAT,Y
LDY #6
EXP010 ASL A
ROL #5D
DEY
BNE EXP010
STA #3C
EXP020 LDY #0
EXP030 LDA #3
STA HOLDA
EXP040 LDA #128
STA CODE1
EXP050 LDA (R5C),Y
AND CODE1
BEQ EXP070
LDA CODE2
STA CODE3
STA CODE4
EXP060 JSR BITPLT
DINC EVAL
DEC CODE3
BNE EXP060
LDA XVAL
SEC
SBC CODE2
STA XVAL
LDA XVAL+1
SBC #0
STA XVAL+1
LDA CODE2
STA CODE3
INC YVAL
DEC CODE4
BNE EXP060
LDA YVAL
SEC
SBC CODE2
STA YVAL
EXP070 LDA XVAL
CLC
ADC CODE2
STA XVAL
LDA XVAL+1
ADC #0
STA XVAL+1
LBR CODE1
BNE EXP050
INY
CPY #63
BCS EXP080
DEC HOLDA
BNE EXP040
BNE EXP040
LDA XVAL
LDX #30 METER
EXP080 LDA #3C
CMP #<2496 ;TARGET?
BNE EXP090
LDA #5D
CMP #>2496
BNE EXP090
ADDR #5C,2360
LDA #161
STA XVAL
STA HOLDX
LDA #0
STA EVAL+1
LDA #6C
STA YVAL
JMP EXP020
EXP090 RTS
EXPDAT .BYTE 39,113,66,2
.BYTE 41,114,26,4
.BYTE 35,127,61,3
.BYTE 36,116,40,4
.BYTE 37,103,23,5
.BYTE 38, 94, 4,6
;PROCEDURE SHTRAP (SHOTGROUPS)
;POKE #7B WITH START ADDRESS.
;POKE HOLD3,TAR# (ADD 128 IF
;ONLY HIT/MISS INFO IS DESIRED.)
;POKE HOLD4,WITH # OF SHOTS.
;AT END: HITS, MISSES ARE SET.
;HOLD1 WILL HAVE # UNGRAPHABLE
;SHOTS, HOLD2 WILL HAVE TOTAL
;# SHOTS FIRED AT THIS TARGET
SHTRAP LDA #255
STA CHOICE
LDA #0
STA HITS
STA MISSES
STA HOLD1
STA HOLD2
STA HOLDY
LDA HOLD3
AND #127
TAX
SEC
SBC #1
ASL A
ASL A
TAY
LDA EXPDAT+3,Y
STA CODE2
STA CODE1
CPX #3
BCS SHT010
LBR CODE2
SHT010 LDY #100
LDA #255
STA TEMP,Y
SHT020 DEY
BPL SHT020
LDA 1
PHA
LDA #54
STA 1
SHT030 LDY #0
LDX (R5B),
AND #127
CMP CODE1
BNE SHT070
INC HOLD2
LDA (R5B),Y
BHI SHT040
INC HITS
JMP SHT050
SH... INC MISSES
SHT050 LDY #6
SHT060 LDA (R5B),Y
STA LASTSH,Y
DEY
BPL SHT060
STA 1
LDX #<TEMP+100
LDY #>TEMP
JSR PAI1A2
JSR RADERR
JSR PAI1A2
LDA #<TEMP+100
LDY #>TEMP
JSR MEMF1A1
JSR ADD
LDA #36
STA 1
BIT HOLD3
BPL SHT080
SPL SHT080
LDA #0
STA XVAL
STA XVAL+1
STA YVAL
STA YVAL+1
LDA LASTSH+3 ;TARX
LDX #0
ASL A
BCC SHT090
INX
SHT090 STA #7D
STX #7E
LDA LASTSH+1 ;BULX
LDX #0
ASL A
BCC SHT100
INX
SHT100 SBC #7D
SBC #7E
STA #7D
TXA
SBC #7E
STA #7E
LDX CODE2
SHT110 LDA XVAL
CLC
ADC #7D
STA XVAL
LDA XVAL+1
ADC #7E
STA XVAL+1
DEX
BNE SHT110
LDA XVAL
CLC
ADC #160
STA XVAL
TAX
LDA XVAL+1
ADC #0
STA XVAL+1
CMP #2
BCS SHT150
CMP #0
BNE SHT120
CPX #10
BCC SHT150
BCS SHT130
SHT120 CPX #54
BCS SHT150
SHT130 LDY HOLDY
LBR A
TXA
ROR A
STA TEMP,Y
LDA LASTSH+2 ;BULY
SEC
SBC LASTSH+4 ;TARY
STA #7D
LDA #0
SBC #0
STA #7E
LDX CODE2
SHT140 LDA YVAL
CLC
ADC #7D
STA YVAL
LDA YVAL+1
ADC #7E
STA YVAL+1
DEX
BNE SHT140
LDA YVAL
CLC
ADC #100
STA YVAL
TAX
LDA YVAL+1
ADC #0
STA YVAL+1
BNE SHT150
CPX #176
BCS SHT150
CPX #24
BCC SHT150
LDY HOLDY
INY
TXA
STA TEMP,Y
INY
STY HOLDY
JMP SHT160

```

```

SMT150 INC HOLD1
SMT160 LDA SFB
      CLC
      ADC #8
      STA SFB
      LDA SFC
      ADC #0
      STA SFC
      DEC HOLD4
      BEQ SMT170
      JMP SMT030
SMT170 PLA
      STA 1
      BIT HOLD3
      BPL SMT180
      RTS
SMT180 LDY #0
SMT190 LDY #0
      LDA TEMP.Y
      CMP #255
      BEQ SMT240
      STA SFB
      ASL A
      BCC SMT200
      INX
SMT200 SBC
      SBC #1
      STA XVAL
      STA HOLDA
      TBA
      SBC #0
      STA XVAL+1
      STA HOLDX
      LDA TEMP.Y
      STA SFC
      SEC
      SBC #1
      STA YVAL
      LDA #3
      STA CODE3
      STA CODE4
SMT210 JSR BITPLT
      DINC XVAL
      DEC CODE3
      BNE SMT210
      LDA HOLDA
      STA XVAL
      LDA HOLDX
      STA XVAL+1
      INC YVAL
      LDA #3
      STA CODE3
      DEC CODE4
      BNE SMT210
      INY
      INY
      TYA
      TAX
SMT220 LDA TEMP.X
      CMP #255
      BEQ SMT190
      CMP SFB
      BNE SMT230
      LDA TEMP+1,X
      CMP SFC
      BNE SMT230
      INC TEMP.X
      INC TEMP+1,X
SMT230 INX
      INX
      JMP SMT220
SMT240 JSR EXPTAR
      RTS
BITPLT STY HOLDY
      LDA #0
      STA SFD
      STA SFE
      STA SA4
      STA YVAL+1
PL020 LDA YVAL
      AND #248 ;INT(Y/8)*320
      LDY #3
PL030 ASL A
      ROL SA4
      DEY
      BNE PL030
      STA SA3
      LDY #5
PL040 LDA SFD
      CLC
      ADC SA3
      STA SFD
      LDA SFE
      ADC SA4
      STA SFE
      DEY
      BNE PL040
      LDA XVAL ;8*INT(X/8)
      AND #248

```

```

      CLC
      ADC SFD
      STA SFD
      LDA XVAL+1
      ADC SFE
      CLC
      ADC #>8192 ;+8192
      STA SFE
      LDA YVAL ;Y AND 7
      AND #7
      TAY
      LDA XVAL ;X AND 7
      AND #7
      STA SA3
      LDA #7
      SBC
      SBC SA3 ;7-(X AND 7)
      TAX
      LDA #1
      CPX #0
      BEQ PL060
PL050 ASL A ;2*(7-(X
      DEX ; AND 7))
      BNE PL050
      BIT CHOICE
      BPL PL070
      ORA (SFD).Y
      JMP PL080
PL070 BCR (SFD).Y
PL080 STA (SFD).Y
      LDY HOLDY
      RTS
      .END
;PROCEDURE NISCOR
;THIS PROCEDURE CALLS THE NISCOR
; PROCEDURE ON CHOICE. THE ONLY
; REASON IT IS HERE IS BECAUSE
; THE INITIALS BUFFER IS UNDER
; ROM AND ROUTINES RUNNING OFF
; THE EPROM CANNOT BANK OUT ROM
; WITHOUT CRASHING. IT MOVES
; THE INITIALS BUFFER TO TEMP
; BEFORE CALLING AND MOVES IT
; BACK AFTER THE CALL. CODE1
; AND FA1 MUST BE SET (IF APP.)
; BEFORE CALLING THIS ROUTINE.
NISCOR LDA 1
      PHA
      LDA #54
      STA 1
      LDY #79
      LDA INIBUF.Y
      STA TEMP.Y
      DEY
      BPL HIS010
      PLA
      STA 1
      LDA #24
      STA 49168
      JSR SELSUB
      LDY #79
      LDA TEMP.Y
      STA INIBUF.Y
      DEY
      BPL HIS020
      RTS
      .OPT LIST
      .END
      *-32768
;MLCH08K1.TXT
      JMP CTRMOV
      JMP RANDOM
      JMP DODATA
      JMP GETXY
      JMP HELPER
      JMP REKREP
      JMP YESNO
      JMP DESCRP
      JMP NISCOR
      .LIB MACROS-VARS
      .END
      .OPT NOL
BANG -3415
DSABLE -3403
ENABE -3400
NOTTRO -3412
ROTATE -3406
WAIT -3418
WHISTL -3436
PRGNUM -49161
LETHL -49185
      .LIB CTRMOV
;CTRMOV IN MLCH08K1.TXT
CTRMOV JSR ENABE
      LDA #0
      STA NITPR
      STA NUMR20
      STA NUMR20+1
      STA NUMR60

```

```

      STA NUMR60+1
      STA FSTAT
      JSR SBIBF
      LDA 101
      STA IRQ
      LDA 100
      STA IRQ2
      #0
CTR010 LDA
      STA OFFSCR
CTR020 JSR MOVESP
      JSR PAUSE
      BCS CTR030
      JMP CTR410
CTR030 LDA SORTAP
      BNE CTR030
      JSR GETXY ;NO MORE SORT
      JSR CLOSER
      STA CURTAR
      TAX
      BNE CTR040
      JMP CTR110
CTR040 LDA SPECIL.X
      STA SPECIL
      LDA #0
      STA WDRIPT+1
      LDA WIND
      AND #36
      BEQ CTR070
      LDA XDRIPT.X
      ASL A ;RANGE*8
      ASL A
      ASL A
      STA XDRIPT
      LDA WIND ;GET SPEED
      AND #7
      CLC ;ADD TARGET
      ADC XDRIPT ; OFFSET
      TAY
      LDA WIND ;FULL OR
      AND #32 ; HALF VALUE?
      BNE CTR060
      LDA WTABE.Y
      LSR A
      LSR A
      LSR A
      LSR A
      JMP CTR070
CTR060 LDA WTABE.Y
      AND #15
CTR070 STA WDRIPT
      BIT WIND ;NEGATIVE
      BPL CTR080 ; DIRECTION?
      DEC WDRIPT+1
      BCR #255
      STA WDRIPT
      DINC WDRIPT
CTR080 LDA YDRIPT.X
      STA TRAJ
      LDA TIMEPL.X
      BEQ CTR110
      STA CURTF
      LDA INSTR.X
      BEQ CTR110
      LDY HOLDY
      LDA V.X
CTR090 STA HOLDS
      JSR MOVESP
      JSR PAU010
      LDA OFFSCR
      BEQ CTR100
      BCR #255
      AND V+21
      STA V+21
      LDA #0
      STA OFFSCR
CTR100 LDA V+21
      AND HOLDS
      BEQ CTR110
      LDY HOLDS
      LDA V.X
      CMP CTR090
      DEC CURTF
      BNE CTR090
CTR110 LDA XVAL
      CLC
      ADC WDRIPT
      STA XVAL
      STA V
      LDA XVAL+1
      ADC WDRIPT+1
      STA XVAL+1
      LDA YVAL
      CLC
      ADC TRAJ
      STA YVAL
      STA V+1
      LDA V+16
      AND #254

```

```

LDX XVAL+1
SEC CTR120
ORA #1
CTR120 STA V+16
LDA V+28 ;TURN OFF
AND #254 ;MULTICOLOR
STA V+28 ;FOR SPR 0
LDA #34 ;BULLET
STA 2040
LDA #12 ;RED GRAY
STA V+39
LDA #0
STA SSCOL
LDA IRQ2 ;NO CHECK
AND #32 ;FOR
BNE CTR150 ;COLLISION?
LDA V+21 ;TURN ON FOR
ORA #1 ;COLLISION
STA V+21 ;CHECK
LDX #2
CTR130 LDA IRQ ;CHECK FOR
ORA #32 ;COLLISION
CTR140 LDA IRQ
AND #32
BNE CTR140
DEX
BNE CTR130
LDA V+21 ;TURN OFF
AND #254 ;BULLET
STA V+21
CTR150 LDA #0
STA #FC
LDA SHOTS
ASL A
ASL A
ROL SFC
CLC
ADC #<INFO
STA #FB
LDA #FC
ADC #>INFO
STA #FC
LDA SSCOL
AND #254
TAY
LDA #2
STA CODE3 ;2* (HIT SPR#)
LDX #1
CTR160 TYA
STX CODE2
AND CODE3
CLC
BNE CTR170
INX
ASL CODE3
BCC CTR160
LDX #0
STX CODE2
LDX CURTAR
CTR170 LDA TARNUM.X
BCC CTR180
ORA #128
JMP CTR190
CTR180 INC HITS
CTR190 LDY #0
STA TARNUM
STA (SFB),Y ;TARGET ID
STA LASTSH.Y
INX
LDA XVAL+1
LSR A
LDA XVAL
ROR A
STA (SFB),Y ;BULK/2
STA LASTSH.Y
INX
LDA YVAL
STA (SFB),Y ;BULY
STA LASTSH.Y
INX
LDA SPECIL.X
STA SPECIL
LDA CENX.X
STA CENX
LDA CENY.X
STA CENY
TXA
ASL A ;FOR SPR XY
PHA
LDA V+15
CTR200 LSR A ;PUT RIGHT
DEX ;X IN
BPL CTR200 ;CARRY
FLA
TAX
LDA V.X
ROR A ;RIGHT X

CLC ;ADD CENTER X
ADC CENX ;OFFSET
STA (SFB),Y ;TAX/2
STA LASTSH.Y
INX
LDA V+1.X
CLC ;ADD CENTER Y
ADC CENY ;OFFSET
STA (SFB),Y ;TAY
STA LASTSH.Y
LDA IRQ2 ;IS THIS SHOT
AND #4 ;A REPEAT?
BNE CTR220
LDA #FB ;STORE IN
CLC ;END INFO
ADC #344 ;BUFFER
STA #FB ;(DISK
LDA #FC ;RECORDS
ADC #344 ;ONLY HAVE
STA #FC ;ORIGINAL
LDA SHOTS ;SHOT)
CLC
ADC #1
STA SHOTRX
LDY #7
CTR210 LDA LASTSH.Y
STA (SFB),Y
DEY
BPL CTR210
CTR220 LDA XVAL ;PUT UP CROSS
SEC
BSC #10
STA V
LDA XVAL+1
BSC #0
TAX
LDA V+16
AND #254
CTX #0
BEO CTR230
ORA #1
CTR230 STA V+16
LDA YVAL
SEC
BSC #9
STA V+1
LDA #42
STA 2040
LDA V+28 ;MULTICOLOR
ORA #1 ;MODE ON
STA V+28
LDA #1 ;WHITE
STA V+39
LDA IRQ2 ;DON'T
AND #16 ;DISPLAY
BNE CTR250 ;CROSS?
LDA IRQ2
AND #8
BEO CTR240
LDA LASTSH
BPL CTR250
CTR240 LDA V+21
ORA #1
STA V+21
CTR250 LDA SSCOL ;WAS CLOSEST
AND HOLD3 ;TARGET HIT?
BNE CTR260 ;YES
LDX CURTAR
BEO CTR260
LDA SPECIL.X
AND #64 ;REVERSE
BEO CTR260 ;DIRECTION?
LDA INSTX.X
BOR #255
CLC
ADC #1
STA INSTX.X
CTR260 LDA SPECIL
BPL CTR265
JMP CTR340
CTR265 AND #32 ;IS THIS
BEO CTR290 ;TARGET MORE
LDA #128 ;THAN 1 SPR?
STA CODE1
LDX #7
CTR270 LDA V+21
AND CODE1
BEO CTR280
LDA TARNUM.X
CMP TARNUM
BNE CTR280
LDA CODE1
ORA CODE3
STA CODE3
CTR280 LSR CODE1
DEX
BNE CTR270
CTR290 LDA HITSPR ;TURN OFF ANY
BOR #255 ;TARGET PRE-

ORA #1 ;VIOUSLY HIT
AND V+21
STA V+21
LDX LASTSH
LDA IRQ2
AND #16
BEO CTR300
CPX #128
BCC CTR310
JMP CTR320
CTR300 LDA IRQ2 ;SPECIAL
AND #8 ;CROSS?
BEO CTR330
CPX #128 ;MISS?
BCC CTR330
LDA IRQ2 ;IF SET AFTER
AND #128 ;EACH TARGET
BNE CTR320 ;LEAVE IT UP
LDA CODE3 ;TURN OFF
BOR #255 ;BIT TARGET
AND V+21 ;BOM
STA V+21
CTR320 LDA #0
STA HITSPR
JMP CTR340
CTR330 LDA CODE3 ;SET UP TO
ORA #1 ;TURN OFF
STA HITSPR ;MIT TARGET
LDA #0 ;STOP HIT
LDX CODE2 ;TARGET
STA INSTX.X
LDA #30
CTR340 BIT TARNUM
CTR370 BVS
LDX #7 ;CHECK FOR
LDA #128 ;PENALTIES
STA CODE1
CTR350 LDA V+21 ;SPRITE MUST
AND CODE1 ;BE ON
BEO CTR360
LDA TARNUM ;HIT TARGET
AND #127
CMP TARNUM.X
BCC CTR360 ;MUST BE LESS
BEO CTR360 ;OR EQUAL
INC PENAL
JMP CTR370
CTR360 LSR CODE1
DEX
BPL CTR350
CTR370 JSR ROTATE
INC SHOTS
LDA IRQ
AND #251
STA IRQ
LDA SHOTS
CMP MAXSH
BCC CTR400
LDA IRQ
ORA #1
STA IRQ
LDY #87
CTR380 LDA NGAMMO.Y
STA 15776.Y
DEY
BPL CTR390
LDY #10
LDA #13
CTR390 STA 1972.Y
DEY
BPL CTR390
CTR400 SEC
JSR CKBPCL
BCC CTR460
LDA IRQ
AND #1
BEO CTR410
JMP CTR020
CTR410 LDA IRQ
AND #192
BEO CTR460
LDA #6321
CMP #127
BNE CTR420 ;BREAK KEY
LDA #128 ;FLAG
STA FBSTAT
JMP CTR460
CTR420 LDA #FF8C
BNE CTR430
JMP CTR020
CTR430 AND #1 ;WHISTLE
BEO CTR450 ;FLAG
LDA V+21 ;SPRITE ON?
AND #254
BEO CTR440
JSR WHISTL
CTR440 LDA OFFSCR ;CLEAR FLAG
AND #254

```

```

CTR450 STA OFFSCR
LDA OFFSCR
EOR #255
AND V+21
STA V+21
CLC
JBR CTR460
BCS CTR460
JMP CTR460
CTR460 LDA IRQ
AND #15
STA IRQ
MOVE #FB,TARORD
LDY #0
LDA (FB).Y
CMP #254
BNE CTR470
DINC
CTR470 LDA #0
LDY FBSTAT
JBR #B391
RTS
CTR480 LDA IRQ2 ;RETURN WHEN
BNI CTR490 ; NO TARGETS
AND #64 ; UP?
BEQ CTR490
LDA V+21
AND #254
BNE CTR490
BCS CTR490
CTR490 LDA IRQ
AND #192
BNE CTR490
CTR490 SEC
RTS
CTR490 CLC
RTS
MOVESP LDY #14
LDX #7
LDA #128
STA HOLD
MOV010 LDA V+21
AND HOLD
BEQ MOV060
LDA INSTR,X ;STATIONARY?
BEQ MOV060
DEC CDLSTK,X ;MOVE IT?
BNE MOV060
LDA HOLD
AND OFFSCR
BNE MOV060
LDA DLSTK,X
STA CDLSTK,X
LDA HOLD ;CHECK
AND V+16 ; RIGHT X
BEQ MOV020
LDA #1
MOV020 STA HOLDX
LDA INSTR,X ;ADD
STA HOLDY ; INCREMENT
CLC
ADC V,Y
STA V,Y
LDA #0
BIT HOLDY ;INCREMENT<C?
BPL MOV030
#255
MOV030 ADC HCLDX
BFO MC/V040
LDA HCLD
ORA V+16
STA V+16
LDA V,Y
CMP #55
BCS MOV050
JMP MOV060
MOV040 LDA HOLD
EOR #255
AND V+16
STA V+16
LDA V,Y
CMP #10
BCS MOV060
MOV050 LDA HOLD
ORA OFFSCR
STA OFFSCR
MOV060 DEY
DEY
LSR HOLD
DEX
BNE MOV010
RTS
PAUSE LDA IRQ ;TRIG PULL
AND #4
BEQ PAU010
SEC
RTS
PAU010 LDA #66
PAU020 SEC
SBC #1
BNE PAU020
CLC
RTS
CLOSES LDA #255
STA HOLDA ;LOW DISTANCE
LDA #128
STA CODE1 ;SPRITE CODE
STA TARMUM ;FOR MISS
LDA XVAL+1
LSR A
LDA XVAL
ROR A
STA HOLDX ;BULLET X
LDA #0
STA HOLD1
STA HOLD3
LDX #14
CLO010 LDA V+21 ;SPRITE ON?
AND CODE1
BEQ CLO050
LDA V+1,X
SEC
SBC YVAL
BCS CLO020
EOR #255
CLC
ADC #1
CLO020 STA HOLDY ;TARY-BULY
LDA V+16
AND CODE1
CLC
BEQ CLO030
SEC
CLO030 LDA V,X
ROR A
SEC
SBC HOLDX
BCS CLO040
EOR #255
CLC
ADC v1
CLO040 CLC
ADC HOLDY ;XDIF+YDIF
ROR A ;(XDIF+YDIF)/2
CMP HOLDA
BCS CLO050
STA HOLDA
STA HOLD1
LDA CODE1
STA HOLD3
CLO050 LSR CODE1
DEX
DEX
BNE CLO010
LDA HOLD1
LSR A
RTS
WTABLE .BYTE 0.16,17,33,49,66,66,0
.BYTE 0.17,33,50,66,83,115,0
.BYTE 0.17,49,66,99,116,140,0
.BYTE 0.33,66,83,116,140,101,0
.BYTE 0.33,66,99,140,101,215,0
.BYTE 0.49,83,132,181,231,240,0
NOAMMO .BYTE
60,102,102,102,102,102,60,0,102,102,102,10
2,102,102,60,0,126
.BYTE
24,24,24,24,24,24,0,0,0,0,0,0,0,60,102
,102,102,102,102
.BYTE
60,0,126,96,96,120,96,96,96,0,0,0,0,0,0,0
0,0,24,60,102,126
.BYTE
102,102,102,0,99,119,127,107,99,99,99,0,99
,119,127,107,99,99
.BYTE
99,0,60,102,102,102,102,60,0
.END
.OPT MOL
.LIB DATAITEMS
;DATAITEMS FOR BRM PROGRAM
DODATA JBR WHCDAT
LDA #<DITEMS
CLC
ADC STOP
STA STOP
LDA #>DITEMS
ADC STOP+1
STA STOP+1
ADDR #FD,52480
LDY #0
DOD010 LDA (FB).Y
STA (FPD).Y
DINC #FB
DINC #FD
LDA #FB
CMP STOP
BCC DOD010
LDA #FC
CMP STOP+1
BCC DOD010
RTS
;PROCEDURE RANDOM
;POKE STOP WITH THE STARTING LOC
; IN STACK (X-START-16325)
; AND 16325-XXXXXX WITH THE DATA
; ITEMS. POKE HOLD1,HOLD2 WITH
; ADDRESS OFFSET OF DATA TO BE
; MOVED.
RANDOM LDX STOP
ADDR #FD,52480
RAM010 JBR WHCDAT
LDA 16325,X
BMI RAM020
JBR SEARCH
INX
BNE RAM010
RAM020 LDY #0
LDA #255
STA (FPD).Y
RTS
SEARCH STA #A3
STX #A4
LDY #0
LDX #0
CMP #0
BEQ RAM060
RAM030 LDA (FPD).Y
DINC #FB
TAX
RAM040 LDA #FB
CLC
ADC #14
STA #FB
LDA #FC
ADC #0
STA #FC
DEX
BNE RAM040
LDA (FB).Y
BPL RAM050
DINC #FB
DEC #A3
BNE RAM030
RAM060 LDA (FB).Y
STA #A3
STA (FPD).Y
INX
RAM070 LDX #14
RAM080 LDA (FB).Y
STA (FPD).Y
INX
DEX
BNE RAM080
DEC #A3
BNE RAM070
LDA (FB).Y
BPL RAM090
STA (FPD).Y
INX
RAM090 TAY
CLC
ADC #FD
STA #FD
LDA #FE
ADC #0
STA #FE
LDX #A4
RTS
WHCDAT LDA #<DITEMS
CLC
ADC HOLD1
STA #FB
LDA #>DITEMS
ADC HOLD1+1
STA #FC
RTS
;ZERO DATA (0-16)
DITEMS .BYTE
1,0,160,5,37,12,255,0,0,0,4,0,0,6,15,254,2
55
;EXTENDED PARTTEST DATA (17-115)
.BYTE 1,141,159, 1, 41,204, 10, 0,
0, 0, 1,254, 0, 12, 36,254
.BYTE 1,107,150, 4, 37, 12, 16, 0,
0, 0, 4, 0, 0, 6, 15,254
.BYTE 1, 93,140, 5, 38, 12, 10, 0,
0, 0, 5, 1, 0, 6, 16,254
.BYTE 1,193,159, 1, 41,204, 10, 0,
0, 0, 1,254, 0, 12, 36,254
.BYTE 1, 75,150, 4, 37, 12, 16, 0,
0, 0, 4, 0, 0, 6, 15,254
.BYTE 1,149,140, 5, 38, 12, 10, 0,
0, 0, 5, 1, 0, 6, 16,254,255
;LEVELS 1-4 (114-224)
.BYTE 2, 0,169, 1, 39,204, 8, 0,
0, 0, 0,255, 32, 24, 34

```

```

.BYTE 0.169, 1, 40,204, 8, 0,
0, 0, 0.255, 32, 0, 34,254
.BYTE 1, 0.159, 2, 41,204, 11, 0,
0, 1,254, 0, 12, 37,254
.BYTE 1, 0.170, 3, 35, 12, 13, 0,
0, 2,254, 0, 6, 13,254
.BYTE 1, 0.160, 4, 36, 12, 16, 0,
0, 3,255, 0, 6, 13,254
.BYTE 1, 0.150, 5, 37, 12, 19, 0,
0, 4, 0, 0, 6, 15,254
.BYTE 1, 0.140, 6, 38, 12, 21, 0,
0, 5, 1, 0, 6, 16,254,255
/LEVELS 3-9 (223-912)
.BYTE 1,243,152, 2, 41,204, 8, 0,
0, 1,254, 0, 12, 37,254
.BYTE 1,131,160, 3, 35, 12, 10, 0,
0, 2,254, 0, 6, 13,254
.BYTE 2, 49,165, 1, 39,204, 6, 0,
0, 0,255, 32, 24, 34
.BYTE 97,165, 1, 40,204, 6, 0,
0, 0,255, 48, 0, 34,254
.BYTE 1,131,160, 3, 35, 12, 10, 0,
0, 2,254, 0, 6, 13,254
.BYTE 1,231,115, 4, 38, 12, 16, 0,
0, 5, 1, 0, 6, 16,254
.BYTE 1,219,145, 4, 36, 12, 12, 0,
0, 3,255, 0, 6, 15,254
.BYTE 1,195,130, 5, 37, 12, 14, 0,
0, 4, 0, 0, 6, 15,254
.BYTE 2, 49,165, 1, 39,204, 4, 0,
0, 0,255, 32, 24, 34
.BYTE 97,165, 1, 40,204, 6, 0,
0, 0,255, 48, 0, 34,254
.BYTE 1,219,145, 4, 36, 12, 12, 0,
0, 3,255, 0, 6, 15,254
.BYTE 2,131,160, 3, 35, 12, 20, 0,
0, 2,254, 0, 6, 13
.BYTE 231,115, 6, 38, 12, 20, 0,
0, 5, 1, 0, 6, 16,254
.BYTE 2,243,152, 2, 41,204, 16, 0,
0, 1,254, 0, 12, 37
.BYTE 219,145, 4, 36, 12, 16, 0,
0, 3,255, 0, 6, 15,254
.BYTE 3, 49,165, 1, 39,204, 12, 0,
0, 0,255, 32, 24, 34
.BYTE 97,165, 1, 40,204, 12, 0,
0, 0,255, 48, 0, 34
.BYTE 243,152, 2, 41,204, 12, 0,
0, 1,254, 0, 12, 37,254
.BYTE 1,131,160, 3, 35, 12, 10, 0,
0, 2,254, 0, 6, 13,254
.BYTE 1,195,130, 5, 37, 12, 16, 0,
0, 4, 0, 0, 6, 15,254
.BYTE 3, 49,165, 1, 39,204, 16, 0,
0, 0,255, 32, 24, 34
.BYTE 97,165, 1, 40,204, 16, 0,
0, 0,255, 48, 0, 34
.BYTE 151,160, 3, 35, 12, 16, 0,
0, 2,254, 0, 6, 13,254
.BYTE 1,243,152, 2, 41,204, 10, 0,
0, 1,254, 0, 12, 37,254
.BYTE 1,131,160, 3, 35, 12, 12, 0,
0, 2,254, 0, 6, 13,254
.BYTE 3, 49,165, 1, 39,204, 16, 0,
0, 0,255, 32, 24, 34
.BYTE 97,165, 1, 40,204, 16, 0,
0, 0,255, 48, 0, 34
.BYTE 219,145, 4, 36, 12, 16, 0,
0, 3,255, 0, 6, 15,254
.BYTE 1,243,152, 2, 41,204, 10, 0,
0, 1,254, 0, 12, 37,254
.BYTE 2,131,160, 3, 35, 12, 24, 0,
0, 2,254, 0, 6, 13
.BYTE 219,145, 4, 36, 12, 24, 0,
0, 3,255, 0, 6, 15,254
.BYTE 1,231,115, 4, 38, 12, 19, 0,
0, 5, 1, 0, 6, 16,254
.BYTE 2,243,152, 2, 41,204, 16, 0,
0, 1,254, 0, 12, 37
.BYTE 131,160, 3, 35, 12, 16, 0,
0, 2,254, 0, 6, 13,254
.BYTE 1,131,160, 3, 35, 12, 16, 0,
0, 2,254, 0, 6, 13,254
.BYTE 2,243,152, 2, 41,204, 20, 0,
0, 1,254, 0, 12, 37
.BYTE 219,145, 4, 36, 12, 20, 0,
0, 3,255, 0, 6, 15,254
.BYTE 2,131,160, 3, 35, 12, 24, 0,
0, 2,254, 0, 6, 13
.BYTE 195,130, 5, 37, 12, 24, 0,
0, 4, 0, 0, 6, 15,254
.BYTE 2,243,152, 2, 41,204, 16, 0,
0, 1,254, 0, 12, 37
.BYTE 1,101,160, 3, 35, 12, 10, 0,
0, 2,254, 1, 6, 13,136,140
/ATTACK/RETRAT 1 (913-1866)
/SCREEN 1
.BYTE 1,147,115, 6, 38, 12, 8, 0,
0, 5, 1, 1, 6, 16,136,140
/SCREEN 2
.BYTE 1,233,115, 6, 38, 12, 14, 0,
0, 5, 1, 1, 6, 16, 0
.BYTE 1,131,130, 5, 37, 12, 12, 0,
0, 4, 0, 1, 6, 15, 0
.BYTE 1, 79,115, 6, 38, 12, 10, 0,
0, 5, 1, 1, 6, 16,130,130
/SCREEN 3
.BYTE 2,171,130, 5, 37, 12, 8, 0,
0, 4, 0, 2, 6, 15
.BYTE 63,145, 4, 36, 12, 8, 0,
0, 3,255, 2, 6, 15,136,134
/SCREEN 4
.BYTE 2, 13,130, 5, 37, 44, 16, 0,
0, 4, 0, 2, 6, 15
.BYTE 59,145, 4, 36, 12, 16, 0,
0, 3,255, 2, 6, 15,131
.BYTE 1,211,160, 3, 35, 12, 12, 0,
0, 2,254, 1, 6, 13,131
.BYTE 1,103,145, 4, 36, 12, 8, 0,
0, 3,255, 1, 6, 15,136,140
/SCREEN 5
.BYTE 1,253,160, 3, 35, 12, 8, 0,
0, 2,254, 1, 6, 13, 0
.BYTE 1, 43,132, 2, 41,204, 6, 0,
0, 1,254, 1, 12, 37,134,134
/SCREEN 6
.BYTE 1,181,160, 3, 35, 12, 12, 0,
0, 2,254, 1, 6, 13,131
.BYTE 1,251,152, 2, 41,204, 8, 0,
0, 1,254, 1, 12, 37,131
.BYTE 2, 41,165, 1, 39,204, 4, 0,
0, 0,255, 32, 24, 34
.BYTE 89,165, 1, 40,204, 4, 0,
0, 0,255, 48, 0, 34,132,130
.BYTE 3, 47,152, 2, 41,204, 20, 0,
0, 1,254, 3, 12, 37
.BYTE 189,152, 2, 41,204, 20, 0,
0, 1,254, 3, 12, 37
.BYTE 19,160, 3, 35, 44, 20, 0,
0, 2,254, 3, 6, 13,140
.BYTE 3,107,152, 2, 41,204, 8, 0,
0, 1,254, 2, 12, 37
.BYTE 207,165, 1, 39,204, 8, 0,
0, 0,255, 34, 24, 34
.BYTE 255,165, 1, 40,204, 8, 0,
0, 0,255, 50, 0, 34,136,130
.BYTE 5, 29,165, 1, 39,204, 20, 0,
0, 0,255, 36, 24, 34
.BYTE 77,165, 1, 40,204, 20, 0,
0, 0,255, 52, 0, 34
.BYTE 91,152, 2, 41,204, 20, 0,
0, 1,254, 4, 12, 37
.BYTE 153,152, 2, 41,204, 20, 0,
0, 1,254, 4, 12, 37
.BYTE 255,152, 2, 41,204, 20, 0,
0, 1,254, 4, 12, 37,144
.BYTE 1,221,160, 3, 35, 12, 4, 0,
0, 2,254, 1, 6, 13,132,134
/SCREEN 9
.BYTE 1,205,152, 2, 41,204, 12, 0,
0, 1,254, 1, 12, 37, 0
.BYTE 1,101,160, 3, 35, 12, 10, 0,
0, 2,254, 1, 6, 13, 0
.BYTE 1,205,160, 3, 35, 12, 8, 0,
0, 2,254, 1, 6, 13,136,140
/SCREEN 10
.BYTE 1,111,160, 3, 35, 12, 8, 0,
0, 2,254, 1, 6, 13, 0
.BYTE 1,255,145, 4, 36, 12, 6, 0,
0, 3,255, 1, 6, 15,134,134
/SCREEN 11
.BYTE 3,241,160, 3, 35, 12, 16, 0,
0, 2,254, 3, 6, 13
.BYTE 99,145, 4, 36, 12, 16, 0,
0, 3,255, 3, 6, 15
.BYTE 215,145, 4, 36, 12, 16, 0,
0, 3,255, 3, 6, 15,132
.BYTE 1,131,130, 5, 37, 12, 12, 0,
0, 4, 0, 1, 6, 15,140,138
/SCREEN 12
.BYTE 1,101,130, 5, 37, 12, 8, 0,
0, 4, 0, 1, 6, 15,132
.BYTE 1,239,130, 5, 37, 12, 4, 0,
0, 4, 0, 1, 6, 15,132,136
/SCREEN 13
.BYTE 2,147,115, 6, 38, 12, 14, 0,
0, 5, 1, 2, 6, 16
.BYTE 63,130, 5, 37, 12, 14, 0,
0, 4, 0, 2, 6, 15, 0

```

```

82 .BYTE 32,133,' .S,217,197,211,'
   .151,133
   .BYTE 157,157,'NO',145,13
83 .BYTE 32,133,'
   .151,157,157,157,133,'YES',133,'
   .BYTE 5,206,207,133,145,13
84 .BYTE 5,133,'
   .217,197,211,'
85 .BYTE 5,133,' .206,207,'

.OPT LIST
.END
.OPT HOL
.LIB DESCRIPTIONS
DESCAP ADDR 87B,DESC
LDX HOLD1
BEO DES050
LDY 00
DES010 BEX DES020
BEO DES020
LDA (87B),Y
CLC
ADC 01
CLC
ADC 87B
STA 87B
LDA 87C
ADC 00
STA 87C
JMP DES010
DES020 LDA 840
SBC (87B),Y
LSR A
TAY
LDX 00
DES030 LDA 032
STA TEMP,X
INX
DEY
BNE DES030
LDA (87B),Y
STA HOLD1
INY
DES040 LDA (87B),Y
STA TEMP,X
INX
INY
DEC HOLD1
BNE DES040
STX LENSTR
ADDR 8A3,TEMP
JSR LETHL
RTS
DES050 INC HOLD1
LDA HOLD1
DES060 CMP 87D :START
BNE DES070
LDX 014 :LIGHT BLUE
STX 046
DES070 CMP 87E :FINAL
BCC DES080
BEO DES080
LDX 00 :BLACK
STX 046
DES080 LDX 032
STX TEMP
STX TEMP+3
ORA 046
STA TEMP+1
CMP 058
BNE DES090
LDA 0'1
STA TEMP
LDA 0'0
STA TEMP+1
DES090 LDA 0'1
STA TEMP+2
LDY 00
LDA (87B),Y
PHA
TAY
DES100 LDA (87B),Y
STA TEMP+3,Y
DEY
BNE DES100
TAY
DINC
CLC
ADC 87B
PHA
LDA 87C
ADC 00
PHA
LDA 87D
PHA
LDA 87E
PHA

```

```

LDA 013
STA TEMP+4,Y
INY
INY
INY
INY
INY
ADDR 8A3,TEMP
STY LENSTR
JSR LETHL
PLA
STA 87E
PLA
STA 87D
PLA
STA 87C
PLA
STA 87B
INX HOLD1
LDA HOLD1
CMP 010
BEO DES110
JMP DES060
DES110 RTS
DESC .BYTE
31,201,'INTRODUCTION',211,'UPPORTED
'208,'OSITION'
.BYTE
33,201,'INTRODUCTION',213,'MSUPPORTED
'208,'OSITION'
.BYTE 32,212,'INED
'212,'ARGETS',211,'UPPORTED
'208,'OSITION'
.BYTE 34,212,'INED
'212,'ARGETS',213,'MSUPPORTED
'208,'OSITION'
.BYTE 22,208,'RACTICE',210,'ECORD
'198,'IRE',201
.BYTE 23,208,'RACTICE',210,'ECORD
'198,'IRE',201,201
.BYTE 11,210,'ECORD',198,'IRE'
.BYTE 17,210,'APID',210,'ECORD
'198,'IRE'
.BYTE 11,195,'OMBAT',198,'IRE'
.END
.LIB GETXYSORT
;GETXY AND SORT
;PROCEDURE GETXY
;DETERMINE BULLET STRIKE
;B:NONE
;C:SYS GETXY
;A:PUTS THE BULLET STRIKE (X AND Y
; VALUES) IN XVAL AND YVAL.
GETXY LDA STSIZE
STA NSRT
JSR SORT
LDA STSIZE :FIND THE
LSR A : MEDIAN OF
TAX : THE SRTBUT
LDA SRTBUT,X
ASL A :*2
STA XVAL :SET UP FOR
LDA 00 : ADDITION OF
BCC GXY10 : OFFSET X
LDA 01 : BULLET RIGHT
GXY10 STA XVAL+1
DADD XVAL,OFFX
LDA STSIZE :FIND MEDIAN
LSR A : OF THE
CLC : Y HALF OF
ADC STSIZE : THE SRTBUT
TAX
LDA SRTBUT,X
STA YVAL :Y MEDIAN
LDA 00 :SET UP FOR
STA YVAL+1 :OFFSET ADD Y
DADD YVAL,OFFY
RTS
;
;PROCEDURE SORT
;SORTS NSRT ELEMENTS IN SRTBUT
;B:POKE NSRT. (4 OF ELEMENTS)
;C:SYS SORT
;A:ELEMENTS IN SRTBUT ARE SORTED
SORT ADDR 87D,SRTBUT
LDY NSRT
BEO SRT30
DEY
BEO SRT30
STY HOLD
LDY 00
SRT10 LDA (87D),Y
INY
CMP (87D),Y
BCC SRT20 :DON'T SORT
TAX :SWAP X VALS
LDA (87D),Y
DEY
STA (87D),Y

```

```

INY
TXA
STA (87D),Y
TYA :SWAP CORRE-
CLC : SPONDING Y
NSRT : VALUES
TAY
DEY
LDA (87D),Y
TAX
INY
LDA (87D),Y
DEY
STA (87D),Y
INY
TXA
STA (87D),Y
TYA
SBC
NSRT
TAY
SRT20 CPY HOLD
BNE SRT10
LDY 00
SBC HOLD
BNE SRT10
SRT30 RTS
.END
.LIB HELPSCREENS
;PROCEDURE HELPSC
;POKE APPROPRIATE NUMBER IN 87B
; BEFORE CALLING
HELPSC LDA 87B
CMP 01
BEO HLP010
JMP HLP040
;TARGET ARRAY (87B-1)
HLP010 DSPL 8A5010,1285020
LDY 07
HLP020 LDA 012
STA V+39,Y
TYA
CLC
ADC 034
STA 2040,Y
DEY
BNE HLP020
LDA 024
STA V+16
LDA 0224
STA V+23
STA V+29
LDY 013
HLP030 LDA SPLOC1,Y
STA V+2,Y
DEY
BPL HLP030
LDA 0254
STA V+21
RTS
HLP040 CMP 02
BEO HLP050
RTS
;WIND INSTRUCTIONS (87B-2)
HLP050 LDA 039 :50 METER
STA 2044 : TARGET IN
LDA 040 : SP 4-5
STA 2045
LDA 035 :150 METER
STA 2046 : IN SP 6
LDA 030 :300 METER
STA 2047 : IN SP 7
LDY 03
LDA 012
HLP060 STA V+43,Y
DEY
BPL HLP060
LDY 03
HLP070 LDA 043 :SIGHT POST
STA 2040,Y : IN SP 1-3
LDA 00
STA V+39,Y
DEY
BNE HLP070
LDA 042
STA V+23
STA V+29
LDA 0136
STA V+16
LDA 00
STA V+28
LDY 013
HLP080 LDA SPLOC2,Y
STA V+2,Y
DEY
BPL HLP080
LDX 00 :50 M
JSR GETWIND
CLC

```

```

ADC V+2
STA V+2
LDX #16      ;150 M
JSR GETWMD
CLC
ADC V+4
STA V+4
LDX #40      ;300 M
JSR GETWMD
CLC
ADC V+6
STA V+6
LDX #254
STA V+21
GETWMD LDA WIND
AND #96
BRQ GTW020
STX #96
LDA WIND
AND #7
CLC
ADC STX
TAX
LDA WIND
AND #32
BNE GTW010
LDA #TABLE.X
LSR A
LSR A
LSR A
LSR A
JMP GTW020
GTW010 LDA #TABLE.X
AND #15
GTW020 BIT WIND
BNI GTW030
BOR #255
GTW030 RTS
SFLOC1 .BYTE
166,170,226,160,10,150,50,140,40,169,88,16
9,130,153
SFLOC2 .BYTE
72,178,173,150,17,131,48,169,96,169,185,17
0,29,140
HMS010 .BYTE
134,'09',144,147,135,'13',133,137,'0706',2
12,'ARCTY RANGES'
133,137,'07215',207,'M',137,'14191',207,20
7,'M'
137,'201815',207,'M',137,'25172',207,207,'
M'
137,'301625',207,'M',137,'35143',207,207,'
M',144
HMS020 ==
.END
.LIB HIGHSORE
;PROCEDURE HIGSCOR
;ALL OF THESE ROUTINES ARE CALLED
; FROM HIGSCOR IN THE 3400-8191
; MACHINE LANGUAGE AREA.
HIGSCOR LDX CODE1
BNE HIS010
JSR GETIMI ;CODE1=0
RTS
;ROUTINE TO GET LAST FIRER'S
; RANKING. SCORE SHOULD BE IN
; FA1 AND CODE1=1. RANK WILL BE
; RETURNED IN THE VARIABLE RANK.
HIS010 DEX
BNE HIS060
LDA #1
STA RANK
LDY #3
HIS020 LDX #0
HIS030 LDA TEMP,Y
CMP #97.X
BCC HIS050
BNE HIS040
INX
INX
CPX #5
BCC HIS030
BCS HIS050
HIS040 LDA RANK
ASL A
ASL A
ASL A
CLC
ADC #3
TAX
INC RANK
CPY #93
RCC HIS020
HIS050 RTS
HIS060 DEX
BEQ HIS070

```

```

JMP HIS130
;ROUTINE TO STORE INITIALS AND
; PRESENT A LITTLE DEMO. SET
; CODE1=2, PUT SCORE IN FA1 AND
; PUT RANKING IN RANK BEFORE
; CALLING.
HIS070 LDA RANK
STA HOLD1
LDA #11
STA RANK
JSR HIS130
LDA #43
STA #2047
LDA #0
STA V+16
STA V+28
LDA #128
STA V+23
STA V+29
LDA #1
STA V+46
LDX #0
HIS080 TAX
ASL A
TAX
LDA GUNSP1.Y
STA V+14
LDA GUNSP1+1,Y
STA V+15
LDA #128
STA V+21
LDY #1
JSR HSWAIT
INX
CPX #10
BCC HIS080
HIS090 STX HOLD2
TAX
SEC
SBC #1
ASL A
TAX
LDA GUNSP1.Y
STA V+14
LDA GUNSP1+1,Y
STA V+15
LDY #1
LDY #1
JSR HSWAIT
JSR HSWAIT
JSR HSWAIT
LDX HOLD2
CPX HOLD1
BEQ HIS100
DEX
BNE HIS090
HIS100 STX RANK
DEX
TAX
ASL A
ASL A
ASL A
TAX
LDX #0
HIS110 LDA INIT8,X
STA TEMP,Y
INX
INX
CPX #3
BCC HIS110
LDX #0
HIS120 LDA #97.X
STA TEMP,Y
INX
INX
CPX #5
BCC HIS120
LDA #0
STA V+21
JSR HIS140
LDY #8
JSR HSWAIT
RTS
;ROUTINE WHICH PRINTS THE INITIALS
; FROM TEMP. SET CODE1=3 AND PUT
; RANKING IN RANK BEFORE CALLING.
; IF THIS ROUTINE IS CALLED AT
; HIS140, ONLY THE INITIALS ARE
; PRINTED (THE SCREEN IS NOT
; CLEARED AND 'HIGH SCORE' IS NOT
; REPRINTED).
HIS130 ADDR #A3,PINMS1
LDA #PINMS2-PINMS1
STA LENSTR
JSR LETHL
HIS140 LDY #BOARD1-PINMS2
STY LENSTR

```

```

HIS150 LDA PINMS2-1,Y
STA #192-1,Y
DEY
BNE HIS150
LDY #7
LDX #0
LDA #1
STA HOLD
LDA HOLD
HIS160 CMP RANK
BNE HIS170
LDA #5
STA #192,Y
HIS170 LDA TEMP,X
STA #192+4,Y
LDA TEMP+1,X
STA #192+5,Y
LDA TEMP+2,X
STA #192+6,Y
TAX
CLC
ADC #8
TAX
TAX
CLC
ADC #12
TAX
INC HOLD
LDA HOLD
CMP #11
BCC HIS160
ADDR #A3,#192
JSR LETHL
RTS
GETIMI ADDR #A3,BOARD1
LDA #BOARD2-BOARD1
STA LENSTR
JSR LETHL
LDA #15
STA HOLD
INI010 ADDR #A3,BOARD2
LDA #BOARD3-BOARD2
STA LENSTR
JSR LETHL
DEC HOLD
BNE INI010
ADDR #A3,BOARD3
LDA #BOARD4-BOARD3
STA LENSTR
JSR LETHL
LDA #3
STA HOLD
INI020 ADDR #A3,BOARD4
LDA #BOARD5-BOARD4
STA LENSTR
JSR LETHL
DEC HOLD
BNE INI020
ADDR #A3,BOARD5
LDA #BOARD6-BOARD5
STA LENSTR
JSR LETHL
JSR DSABLE
LDA #0
STA V+23
STA V+29
STA V+38
STA #196
STA HOLD1
LDA #1
STA V+39
STA V+26
LDA #42
STA #2040
INI030 LDX #0
LDA #3267
ASL A
STA KVAL
BCC INI040
INX
INI040 STX KVAL+1
LDA #3268
STA YVAL
LDA KVAL
CLC
ADC OFFX
STA KVAL
LDA KVAL+1
ADC OFFX+1
STA KVAL+1
LDA KVAL
SEC
SBC #10
STA KVAL
LDA KVAL+1
SBC #0
STA KVAL+1
LDA YVAL
CLC

```



```

LDA SA3
CLC
ADC #40
STA SA3
LDA SA4
ADC #0
STA SA4
DEX
BNE INL010
INL030 LDA SA1
AND #2
BEQ INL060
LDA #15 ;GUN BANG
STA 34296
LDA #10
STA 34277
LDA #30
STA 34273
LDA #128
STA 34276
LDA #129
STA 34276
LDA #15
STA V ;X: SPRITE 0
LDA #208
STA V+1 ;Y: SPRITE 0
LDA #1
STA V+16 ;RIGHT X
STA V+21 ;SPRITE CTREG
LDA #0
STA SA1
LDA CTAREG
ORA #8
STA CTAREG
ADDR 8A3,1334
INL040 LDY #9
LDY #6
INL050 STA (SA3),Y
DEY
BPL INL050
LDA SA3
CLC
ADC #40
STA SA3
LDA SA4
ADC #0
STA SA4
DEX
BNE INL040
LDA #<13960
STA #FD
LDA #<13968
STA #C3
LDA #>13968
STA #FE
LDA #C4
LDA #5
STA GUNDL
INL060 LDA CTAREG
AND #1
BEQ INL120
LDA SA2 ; SCROLL
AND #7
BNE INL120
LDY #0
INL070 LDA 15880.Y
STA 15872.Y
INP
BNE INL070
INL080 LDA 16116.Y
STA 16128.Y
INP
CPY #56
BNE INL080
LDY #7
INL090 LDA (SPB).Y
CMP #254
BEQ INL100
STA 16184.Y
DZV
BPL INL090
LDA #FB
CLC
ADC #8
STA #FB
LDA #FC
ADC #0
STA #FC
JMP INL120
INL100 LDA #0
STA 16184.Y
DEY
BPL INL100
DEC SCRCT1
BNE INL120
LDA #3
STA SCRCT2
EOR CTAREG

```

```

STA CTAREG
LDY #39
LDA #33
INL110 STA 1984.Y
BPL INL110
INL120 LDA CTAREG
AND #2
BEQ INL140
LDY #252 ;BLINK
INL130 LDA PTTB-1.Y
STA 15919.Y
DEY
BNE INL130
LDA #180
STA SCRCT1
LDA CTAREG
EOR #66
STA CTAREG
INL140 LDA CTAREG
AND #8
BEQ INL160
LDY #0 ;KICK LEFT
INL150 LDA (SC3).Y
STA (SPD).Y
INP
CPY #240
BNE INL150
LDA #C3
CLC
ADC #64
STA #C3
LDA #C4
ADC #1
STA #C4
LDA #FD
CLC
ADC #64
STA #FD
LDA #FE
ADC #1
STA #FE
DEC GUNDL
BNE INL160
LDA #10
STA GUNDL
LDA CTAREG
EOR #24
STA CTAREG
INL160 LDA CTAREG
AND #16
BEQ INL170
JMP SPRUPD ;GUN DELAY
DEC GUNDL
BNE INL170
LDA CTAREG
EOR #48
STA CTAREG
LDA #5
STA GUNDL
LDA #<13952
STA #FD
LDA #<13960
STA #C3
LDA #>13960
STA #FE
STA #C4
INL170 LDA CTAREG
AND #32
BEQ INL210
LDY #240 ;KICK RIGHT
JMP SPRUPD
INL180 LDA (SPD).Y
STA (SC3).Y
DEY
CPY #255
BNE INL180
LDA #C3
ADC #64
STA #C3
LDA #C4
ADC #1
STA #C4
LDA #FD
CLC
ADC #64
STA #FD
LDA #FE
ADC #1
STA #FE
DEC GUNDL
BNE INL210
LDA CTAREG
AND #223
STA CTAREG
LDA #0
STA V+21 ;SPRITE CTREG

```

```

ADDR 8A3,1334
LDX #9
INL190 LDY #6
LDA #177
INL200 STA (SA3).Y
DEY
BPL INL200
LDA SA3
CLC
ADC #40
STA SA3
LDA SA4
ADC #0
STA SA4
DEX
BNE INL190
INL210 LDA CTAREG
AND #64
BEQ INL270
DEC SCRCT1 ;DELAY 288
BNE INL270
DEC SCRCT2
BNE INL230
LDA CTAREG
EOR #65
STA CTAREG
ADDR #FB,FM16
LDY #40
STY SCRCT1
DEY
LDA #177
INL220 STA 1984.Y
DEY
BPL INL220
JMP INL230
INL230 LDA SCRCT2
AND #1
BEQ INL240
LDA CTAREG
EOR #66
STA CTAREG
JMP INL270
INL240 LDA #60
STA SCRCT1
INL250 LDY #247
LDA #0
INL260 STA 15912.Y
DEY
BNE INL260
INL270 JMP #8A31 ;X: SPRITE 0
SPRUPD INC V
INC V
INC V
RTS
FM16 .BYTE
126,96,96,120,56,96,96,0,0,0,60,102,102,10
2,60,0,0,0,124
.BYTE
102,96,96,96,0,0,0,0,0,0,0,124,102,102
.124,102,102,124
.BYTE
0,0,0,60,6,62,102,62,0,0,0,62,96,60,6,124,
0,0,24,0,56,24
.BYTE
24,60,0,0,0,60,96,96,96,60,0,0,0,0,0,0,0
.0,124,102,102
.BYTE
124,120,108,102,0,0,24,0,56,24,24,60,0,0,1
4,24,62,24,24,24
.BYTE
0,0,56,24,24,24,60,0,0,0,60,102,126,96,
60,0,0,0,0,0
.BYTE
0,0,0,99,119,127,107,99,99,99,0,0,0,60,6,6
2,102,62,0,0,0
.BYTE
124,102,96,96,96,0,0,96,96,108,120,108,102
,0,0,0,62,96,60
.BYTE
6,124,0,0,0,102,127,127,177,99,0,0,0,60,6,
62,102,62,0,0,0
.BYTE
124,162,102,102,102,0,0,0,62,96,60,6,124,0
,0,96,96,124,102
.BYTE
102,102,0,0,24,0,56,24,24,60,0,0,0,124,102
.102,124,96,96
.BYTE
0,0,0,0,0,0,0,126,24,24,24,24,24,24,0,0,
0,124,102,96,96
.BYTE
96,0,0,0,60,6,62,102,62,0,0,24,0,56,24,24,
60,0,0,0,124,102
.BYTE
102,102,102,0,0,24,0,56,24,24,60,0,0,0,124
,102,102,102,102
.BYTE
0,0,0,62,102,102,62,6,124,254,254,254,254,
254,254,254,254

```

```

PTTB .BYTE
0,102,60,255,60,102,0,0,0,102,60,255,60,10
2,0,0,0,102
.BYTE
60,255,60,102,0,0,0,0,0,0,0,0,0,124,102,
102,124,96
.BYTE
96,96,0,0,0,102,102,102,102,62,0,0,56,24,2
4,24,24,60
.BYTE
0,0,56,24,24,24,24,60,0,0,0,0,0,0,0,0,0,
24,124,24,24
.BYTE
24,14,0,0,0,124,102,96,96,96,0,0,24,0,56,2
4,24,60,0,0
.BYTE
0,62,102,102,62,6,124,0,0,62,102,102,62,6,
124,0,0,60
.BYTE
102,124,96,60,0,0,0,124,102,96,96,96,0,0,0
,0,0,0,0,0
.BYTE
0,0,24,124,24,24,24,14,0,0,0,60,102,102,10
2,60,0,0,0
.BYTE
0,0,0,0,0,0,96,96,124,102,102,124,0,0,0,0,
60,102,124
.BYTE
96,60,0,0,0,62,102,102,62,6,124,0,24,0,56,
24,24,60,0
.BYTE
0,0,124,102,102,102,0,0,0,0,0,0,0,0,0,0,
0,102,60,255
.BYTE
60,102,0,0,0,102,60,255,60,102,0,0,0,102,6
0,255,60,102,0,0,0
.END
FIN
IMDAT .BYTE 202,205,194,135,157,0,0,0
      :JMB 76.5
      .BYTE 215,200,199,135,153,0,0,0
      :MHC 76.5
      .BYTE
205,193,195,135,152,102,102,102
      :MHC 76.2
      .BYTE
193,210,201,135,150,204,204,205
      :ARI 75.4
      .BYTE
204,195,211,135,148,153,153,154
      :LCS 74.3
      .BYTE
215,200,199,135,146,153,153,154
      :MHC 73.3
      .BYTE
202,205,194,135,144,102,102,102
      :JMB 72.2
      .BYTE
205,193,195,135,140,153,1 3,154
      :MAC 70.3
      .BYTE
204,195,211,135,136,102,102,102
      :LCS 68.2
      .BYTE 193,210,201,135,130,51,51,51
      :ARI 65.1
      .OPT LIST
      .END
      .OPT MOL
      /F1 TOGGLE SIZE (IX, 2X)
      /F2 SET CURSOR (X,Y NEXT 4 BYTES)
      /F3 SPECIAL INSTRUCTIONS
      / BIT 0 SET:BLANK SCREEN
      / BIT 1 CLR:UNBLANK SCREEN
      / BIT 1 SET:ENTER TEXT MODE
      / BIT 1 CLR:ENTER GRAPHICS MODE
      / BIT 2 SET:SET UPPER CASE MODE
      / BIT 2 CLR:NO CHANGE
      / BIT 3 SET:SET LOWER CASE MODE
      / BIT 3 CLR:NO CHANGE
      /F5 SCREEN COLOR (IN NEXT 2 BYTES)
      /F6 BORDER COLOR (IN NEXT 2 BYTES)
      /F7 CHARACTER COLOR (NEXT 2 BYTES)
      /F8 RETURN
CODE1 =16376
CODE2 =16377
COLOR =16378
FLAGS =16379
MOLDA =16380
MOLDY =16382
LENSTR =16383
      .MAC ADDR
      LDA @C72
      STA 71
      LDA @D72
      STA 71+1
      .MMD
      .MAC DIM
      INC 71

```

```

BNE 72
.MC 71+1
.MMD
JMP LETERS
JMP LETML
LETML LDA 71
      STA SFD
      LDA 72
      STA SFE
      LDY 60
      LDA (SFD),Y /LENGTH OF
      BNE LET010 /STRING
      RTS
LET010 STA LENSTR
      INY
      LDA (SFD),Y /ADDRESS OF
      STA SFA3 /STRING NOW
      INY
      LDA (SFD),Y / IN SFA3 AND
      STA SFA4 / SFA
      LDY 60
      STY FLAGS /CLEAR FLAGS
      LDA S3272 /WHICH SET?
      AND 62
      BEQ 72+220 /SET 1
      LDA 72+220 /SET 2
      STA 72+220
      LDA 72+220
      AND 72+220
      BEQ 72+220 /SWITCH IN
      AND 72+220 /CHARACTER
      STA 72+220 /ROM
LET030 LDA 60
      STA MOLDA
      LDA 214
      STA SFE
      ASL A
      ASL A
      ASL A
      ASL A
      BCC LET040
      INC MOLDA
LET040 ASL MOLDA
      ASL A
      BCC LET050
      INC MOLDA
LET050 ASL MOLDA
      ASL A
      BCC LET060
      INC SFE
LET060 STA SFD
      LDA MOLDA
      CLC
      ADC SFE
      STA SFE
      LDA 211
      ASL A
      ASL A
      ASL A
      BCC LET070
      INC SFE
LET070 AL: SFD
      STA SFD
      LDA SFE
      ADC 632
      STA SFE
      LDA (SFA3),Y
      STY MOLDY
      CMP 6142
      BNE LET090
      LDA FLAGS
      AND 6251
      STA FLAGS
      JMP LET690
LET090 CMP 614
      BNE LET100
      LDA FLAGS
      ORA 64
      STA FLAGS
      JMP LET690
LET100 CMP 6133
      BNE LET110
      LDA FLAGS
      ORA 61
      STA FLAGS
      JMP LET690
LET110 CMP 6137
      BNE LET160
      JSR BYTE2
      INC LET130
LET120 JMP LET700
LET130 CMP 640
      BCS LET140
      STA 71+1
      BCS
      CMP
      BCS
      ST:
      L 6

```

```

BTY 210
ASL A
ASL A
ASL A
STA MOLDA
STA 209
MUL5 LDA MOLDA
      CLC
      ADC 209
      STA 209
      LDA 210
      ADC 60
      STA 210
      DRY
      BNE MUL5
LET150 JMP LET690
LET160 CMP 6136
      BEQ LET170
      JMP BYTE2
LET170 JSR BYTE2
      BCC LET180
      JMP LET700
LET180 LDA 1
      ORA 64
      STA 1
      LDA MOLDA
      AND 61
      BEQ LET190
      LDA S3265
      AND 6239
      STA S3265
      JMP LET200
LET190 LDA S3265
      ORA 616
      STA S3265
      L 00
      LDA MOLDA
      AND 62
      BEQ LET210
      LDA S3265
      AND 6223
      STA S3265
      LDA S3272
      AND 6247
      STA S3272
      JMP LET220
LET210 LDA S3265
      ORA 632
      STA S3265
      LDA S3272
      ORA 68
      STA S3272
      LDA MOLDA
      AND 64
      BEQ LET230
      LDA S3272
      AND 6253
      STA S3272
      LDA FLAG:
      AND 6251
      STA FLAG:
      LDA MOLDA
      AND 68
      BEQ LET240
      LDA S3272
      ORA 62
      STA S3272
      LDA FLAG:
      ORA 64
      STA FLAG:
LET240 LDA 1
      AND 6251
      STA 1
      LDA MOLDA
      AND 616
      BEQ LET290
      JSR BYTE2
      BCS LET300
      LDX MOLDA
      JSR BYTE2
      BCS LET300
      TXA
      TAY
      LDA 4+6192
      STA SFD
      LDA 6+6192
      STA SFE
      CPY 60
      BEQ LET260
      CPY 625
      BEQ LET290
      BCS LET290
      LDA SFD
      CLC
      ADC 6+6320
      STA 6+6320
      LDA SFE
      ADC 6+6320
      STA SFE
      DEY
      BNE LET290

```

```

LET260 LDY #0
LDA #0
LET270 STA (SPD),Y
IMY
BNE LET270
INC SPY
LET280 STA (SPD),Y
IMY
CPY #64
BCC LET280
LDA SPD
CLC
ADC #64
STA SPD
LDA SPD
ADC #0
STA SPD
INX
CPX #25
BCS LET290
CPX HOLDA
BCC LET260
BEQ LET260
LET290 JMP LET690
LET300 JMP LET700
JMP LET690
LET310 CMP #16 ;REVERSE
BNE LET320 ;ON
LDA FLAGS
ORA #2
STA FLAGS
JMP LET690
LET320 CMP #146 ;REVERSE
BNE LET330 ;OFF
LDA FLAGS
AND #253
STA FLAGS
JMP LET690
LET330 CMP #138 ;F4-ARROWS
BNE LET360
JSR BYT22
BCC LET350
LET340 JMP LET700
LET350 SEC
SBC #1
CMP #8
BCS LET340
ASL A
ASL A
CLC
ADC #4ARROWS
STA SPD
LDA #4ARROWS
ADC #0
STA SPD
JMP LET610
LET350 CMP #135 ;F5-COLOR
BNE LET380
JSR BYT22
BCC LET370
JMP LET700
LET370 LDA #240
STA CODE1
JSR ADJSCR
JMP LET490
LET380 CMP #139 ;F6-BORDER
BNE LET400 ;COLOR
JSR BYT22
BCC LET390
JMP LET700
LET390 TAX
LDA 1 ;SWITCH IN
ORA #4 ;VIC CHIP
STA 1 ;A SECOND
STX $3280 ;BORDER
LDA 1 ;SWITCH OUT
AND #251 ;VIC CHIP
STA 1 ;AGAIN
JMP LET690
LET400 CMP #147 ;CLEAR SCR
BNE LET420
LDA #<0192
STA SPD
LDA #>0192
STA SPD
LDY #0
LET410 LDA #0
STA (SPD),Y
DINC SPD
LDA SPD
CMP #<16192
BNE LET410
LDA SPD
CMP #>16192
BNE LET410
LET420 LDA #>1024
STA 210
LDA #0
STA 209
STA 211
STA 214
JMP LET690
LET430 CMP #29 ;RIGHT ARROW
BNE LET440
JSR TLINE
JMP LET690
LET440 CMP #17 ;DOWN ARROW
BNE LET450
JSR LET710
JMP LET690
SKIP JMP LET690
LET450 CMP #143 ;UP ARROW
BNE LET460
LDA FLAGS
AND #1
STA SPD
BIG1 LDA 214
SEC SRIP
DEC 214
LDA 209
SEC
SBC #40
STA 209
LDA 210
SBC #0
STA 210
DEC SPY
BEQ BIG1
JMP LET690
LET460 CMP #157 ;LEFT ARROW
BNE LET480
LDA FLAGS
AND #1
STA SPD
BIG2 LDA 211
BNE LET470
LDA 214
DEC SRIP
DEC 214
LDA #40
STA 211
LDA 209
SEC
SBC #40
STA 209
LDA 210
SBC #0
STA 210
DEC 211
DEC SPY
BEQ BIG2
JMP LET690
LET480 CMP #13
BNE LET500
LET490 LDA #40
STA 211
JSR TLINE
JMP LET690
LET500 CMP #136 ;F7-CHAR COL
BNE LET570
JSR BYT22
BCC LET510
JMP LET700
LET510 LDA #15
STA CODE1
LDA HOLDA
ASL A
ASL A
ASL A
ASL A
STA HOLDA
JSR ADJSCR
JMP LET690
LET520 CMP #140 ;F8-RETURN
BEQ LET490
CMP #19 ;HOME
BNE LET530
JMP LET420
LET530 LDY #0
LET540 LDA SPECIAL,X
BEQ LET560
CMP (8A3),Y
BEQ LET550
INX
INX
JMP LET540
LET550 INX
LDA SPECIAL,X
STA #44
JMP LET690
LET560 LDA (8A3),Y
CMP #96
BCS LET570
AND #191 ;X<96
JMP LET590
LET570 CMP #161
BCS LET580
AND #223 ;96<X<161
JMP LET590
JMP LET590
AND #127 ;161<X<256
ORA #64
STA SPD
LDA #0
STA SPD
LDX #3 ;*8
LET600 ASL SPD
ROL SPD
DEX
BNE LET600
LDA SPD
CLC
ADC #8D0
STA SPD
LDA FLAGS ;WHICH SET?
AND #4
BEQ LET610 ;SET 1
STA SPD ;SET 2
CLC
ADC #8
STA SPD
LET610 LDA 209
CLC
ADC 211
STA 8C3
LDA 210
ADC #0
STA 8C4
LDX #8
LDA #646
ASL A
ASL A
ASL A
ASL A
STA COLOR
LET620 LDY #0
LDA (SPD),Y ;CHARS
STA HOLDA
LDA FLAGS
BEQ LET640
AND #1
BEQ LET630
JSR DOUBLE
LET630 LDA FLAGS
AND #2
BEQ LET640
LDA HOLDA
EOR #255
STA HOLDA
LDA HOLDA+1
EOR #255
STA HOLDA+1
LET640 LDA HOLDA
STA (SPD),Y ;BIT MAP
LDA (8C3),Y ;COLOR
AND #15
ORA COLOR
STA (8C3),Y
LDA FLAGS
AND #1
BEQ LET660
LDA 214
CMP #24
BEQ LET660
INX
LDA HOLDA
STA (SPD),Y
LDA (8C3),Y ;COLOR
AND #15
ORA COLOR
STA (8C3),Y
LDY #40
STA (8C3),Y
INX
STA (8C3),Y
LDA #8
LDA HOLDA+1
STA (SPD),Y
INX
STA (SPD),Y
D7MC SPD
D7MC SPD
DEX
BNE LET650
INC 211
DEC SPD
LDA SPD
SEC
SBC #64
STA SPD
LDA SPD
SBC #0
STA SPD
JMP LET680
LET650 CPX #4
BNE LET670
LDA SPD

```

```

CLC
ADC #56
STA SFD
LDA SFE
ADC #1
STA SFE
JMP LET620
LET660 LINC SFD :BIT MAP
DINC SFB :CHARS
DEX
BEQ LET680
LET670 JMP LET620
LET680 JSR TLINE
LET690 LDY HOLDY
INY
DEC LENSTR
BEQ LET700
JMP LET030
LET700 RTS
TLINE INC 211
LDA 211
CMP #40
BCC LET730
LDA #0
STA 211
LET710 LDA FLAGS
AND #1
STA SFT
LET720 LDA 214
CMP #24
BEQ LET730
INC 214
LDA 209
CLC
ADC #40
STA 209
LDA 210
ADC #0
STA 210
DEC SFT
BEQ LET720
LET730 RTS
ADJSCR LDY #<1024
STY SFD
LDY #>1024
STY SFE
ADJ01 LDY #0
LDA (SFD).Y
AND CODE1
ORA MOLDA
STA (SFD).Y
DINC SFD
LDY SFD
CPY #<2024
BNE ADJ01
LDY SFE
CPY #>2024
BNE ADJ01
RTS
DOUBLE TXA
PHA
LDA MOLDA
LDX #0
STX MOLDA
STX MOLDA+1
TXA
LDA #128
STA CODE1
LDA #192
STA CODE2
DBL1 TXA
AND CODE1
BEQ DBL2
LDA CODE2
ORA MOLDA
STA MOLDA
LSR CODE1
LSR CODE2
BNE DBL1
LDA #192
STA CODE2
DBL3 TXA
AND CODE1
BEQ DBL4
LDA CODE2
ORA MOLDA+1
STA MOLDA+1
LSR CODE2
LSR CODE1
BNE DBL3
PLA
TXA
RTS
BYTE2 JSR UPDATE
BCS BTL20
SEC
BSC #0

```

```

ASL A
STA MOLDA
LDY #4
BYL10 CLC
ADC MOLDA
DEY
BNE BYL10
STA MOLDA
JSR UPDATE
BCS BYL20
SEC
SBC #0
CLC
ADC MOLDA
STA MOLDA
CLC
BYL20 RTS
UPDATE LDY HOLDY
INY
DEC LENSTR
BNE UP10
SEC
RTS
UP10 LDA (SAJ).Y
STY HOLDY
CLC
RTS
.OPT WOL
SPECIAL .BYTE
144,0,5,1,28,2,159,3,136,4,30,5,31,6
.BYTE
150,7,129,8,149,9,150,10,151,11,152,12
.BYTE 153,13,154,14,155,15,0,0
ARROWS .BYTE
0,24,60,126,24,24,24,24,0,24,120,56,104,96
,192,192
.BYTE
0,4,6,255,255,6,4,0,0,192,192,96,104,56,12
0,24
.BYTE
0,24,24,24,24,126,60,24,0,3,3,6,22,20,30,2
4
.BYTE
0,32,96,255,255,96,32,0,0,24,30,28,22,6,3,
3
.OPT LIST
.END

```

Sight Picture Program Documentation

```

10 POKE800,234:V=53248:CT=821:D1=823:D2=824:LP=825:HP=820:SC=3406:SD=822
20 TO=827:YM=828:BC=0:POKEV=21,0:POKEV=16,0:POKEV=39,2
22 DIMFS(7,3),FR(7,3),TS(7,3):FORJ=40TO46:POKEV=J,0:NEXTJ
30 AS="(F3)09:(CLR)(F5)00:(F6)00:(F1)(GRN)(F2)1605MACS"
40 AS-AS+"(LBLU)(F2)1113Baseline of(F2)1413Aiming(F3)00":GOSUB1060:GOSUB1000:IF(BR)THEN4999
50 AS="(CLR)(SWLC)(LBLU)(F1)(F2)0104Correct Application(F2)0207of(WHT)Sight Alignment(LBLU)"
62 AS-AS+"(F2)0110and(WHT)Aiming(LBLU) Improves(F2)0113Marksmanship Skills"
63 GOSUB1060:GOSUB1003:IF(BR)THEN4999
80 RESTORE AS="(F3)09:(CLR)(F5)00:(F6)00:(F1)(GRN)(F2)1605MACS"
92 AS-AS+"(LBLU)(F2)0309Sight Alignment(F2)1711and(F2)1413Aiming(F2)1315Program(F3)00":GOSUB1060
91 POKE2040,43:POKEV=39,2:POKEV=27,7:POKEV=173:POKEV=1,136
92 FORI=0TO7:FORJ=0TO3:READFS(I,J):NEXTJ:NEXTI:GOSUB1000:IF(BR)THEN4999
93 S1=36624:S2=11:GOSUB1160:AS="(BLK)":GOSUB1060:GOSUB1003
95 AS="(CLR)(SWLC)(BLK)(F5)13(F1)(F2)0503Sight Alignment(F2)1805is(F2)0610Placing Tip of"
96 AS-AS+"(F2)0412Front Sight Post(F2)0214in(RAD)Exact Center(BLK)or"
97 AS-AS+"(F2)0116Rear Sight Aperture":GOSUB1060:BR=1:GOSUB1003:IF(BR)THEN200
102 S1=39777:S2=11:GOSUB1160:AS="(SWLC)(BLK)(F1)(F2)0401Demonstration of(F2)0503Sight Alignment"
104 GOSUB1060:POKE53280,BC:L=0
105 GOSUB1170:POKEHS,2:POKECT,6:POKE2041,40:POKE2042,41:POKEV=40,0:POKEV=41,0
106 FORI=0TO7:POKEV=2,DX(I):POKEV=3,DY(I):POKEV=4,EX(I)+24:POKEV=5,DY(I)
107 POKEV=6,EX(I)+40:POKEV=7,DY(I):POKEV=8,EX(I):POKEV=9,DY(I)+21
108 POKEV=10,EX(I)+24:POKEV=11,DY(I)+21:POKEV=12,EX(I)+40:POKEV=13,DY(I)+21
109 POKEV=14,EX(I)+24:POKEV=15,DY(I)+21:POKEV=16,EX(I)+40:POKEV=17,DY(I)+21
110 POKEV=18,EX(I)+24:POKEV=19,DY(I)+21:POKEV=20,EX(I)+40:POKEV=21,DY(I)+21
111 POKEV=22,EX(I)+24:POKEV=23,DY(I)+21:POKEV=24,EX(I)+40:POKEV=25,DY(I)+21
112 POKEV=26,EX(I)+24:POKEV=27,DY(I)+21:POKEV=28,EX(I)+40:POKEV=29,DY(I)+21
113 POKEV=30,EX(I)+24:POKEV=31,DY(I)+21:POKEV=32,EX(I)+40:POKEV=33,DY(I)+21
114 POKEV=34,EX(I)+24:POKEV=35,DY(I)+21:POKEV=36,EX(I)+40:POKEV=37,DY(I)+21
115 POKEV=38,EX(I)+24:POKEV=39,DY(I)+21:POKEV=40,EX(I)+40:POKEV=41,DY(I)+21
116 POKEV=42,EX(I)+24:POKEV=43,DY(I)+21:POKEV=44,EX(I)+40:POKEV=45,DY(I)+21
117 POKEV=46,EX(I)+24:POKEV=47,DY(I)+21:POKEV=48,EX(I)+40:POKEV=49,DY(I)+21
118 POKEV=50,EX(I)+24:POKEV=51,DY(I)+21:POKEV=52,EX(I)+40:POKEV=53,DY(I)+21
119 POKEV=54,EX(I)+24:POKEV=55,DY(I)+21:POKEV=56,EX(I)+40:POKEV=57,DY(I)+21
120 POKEV=58,EX(I)+24:POKEV=59,DY(I)+21:POKEV=60,EX(I)+40:POKEV=61,DY(I)+21
121 POKEV=62,EX(I)+24:POKEV=63,DY(I)+21:POKEV=64,EX(I)+40:POKEV=65,DY(I)+21
122 POKEV=66,EX(I)+24:POKEV=67,DY(I)+21:POKEV=68,EX(I)+40:POKEV=69,DY(I)+21
123 POKEV=70,EX(I)+24:POKEV=71,DY(I)+21:POKEV=72,EX(I)+40:POKEV=73,DY(I)+21
124 POKEV=74,EX(I)+24:POKEV=75,DY(I)+21:POKEV=76,EX(I)+40:POKEV=77,DY(I)+21
125 POKEV=78,EX(I)+24:POKEV=79,DY(I)+21:POKEV=80,EX(I)+40:POKEV=81,DY(I)+21
126 POKEV=82,EX(I)+24:POKEV=83,DY(I)+21:POKEV=84,EX(I)+40:POKEV=85,DY(I)+21
127 POKEV=86,EX(I)+24:POKEV=87,DY(I)+21:POKEV=88,EX(I)+40:POKEV=89,DY(I)+21
128 POKEV=90,EX(I)+24:POKEV=91,DY(I)+21:POKEV=92,EX(I)+40:POKEV=93,DY(I)+21
129 POKEV=94,EX(I)+24:POKEV=95,DY(I)+21:POKEV=96,EX(I)+40:POKEV=97,DY(I)+21
130 POKEV=98,EX(I)+24:POKEV=99,DY(I)+21:POKEV=100,EX(I)+40:POKEV=101,DY(I)+21
131 POKEV=102,EX(I)+24:POKEV=103,DY(I)+21:POKEV=104,EX(I)+40:POKEV=105,DY(I)+21
132 POKEV=106,EX(I)+24:POKEV=107,DY(I)+21:POKEV=108,EX(I)+40:POKEV=109,DY(I)+21
133 POKEV=110,EX(I)+24:POKEV=111,DY(I)+21:POKEV=112,EX(I)+40:POKEV=113,DY(I)+21
134 POKEV=114,EX(I)+24:POKEV=115,DY(I)+21:POKEV=116,EX(I)+40:POKEV=117,DY(I)+21
135 POKEV=118,EX(I)+24:POKEV=119,DY(I)+21:POKEV=120,EX(I)+40:POKEV=121,DY(I)+21
136 POKEV=122,EX(I)+24:POKEV=123,DY(I)+21:POKEV=124,EX(I)+40:POKEV=125,DY(I)+21
137 POKEV=126,EX(I)+24:POKEV=127,DY(I)+21:POKEV=128,EX(I)+40:POKEV=129,DY(I)+21
138 POKEV=130,EX(I)+24:POKEV=131,DY(I)+21:POKEV=132,EX(I)+40:POKEV=133,DY(I)+21
139 POKEV=134,EX(I)+24:POKEV=135,DY(I)+21:POKEV=136,EX(I)+40:POKEV=137,DY(I)+21
140 POKEV=138,EX(I)+24:POKEV=139,DY(I)+21:POKEV=140,EX(I)+40:POKEV=141,DY(I)+21
141 POKEV=142,EX(I)+24:POKEV=143,DY(I)+21:POKEV=144,EX(I)+40:POKEV=145,DY(I)+21
142 POKEV=146,EX(I)+24:POKEV=147,DY(I)+21:POKEV=148,EX(I)+40:POKEV=149,DY(I)+21
143 POKEV=150,EX(I)+24:POKEV=151,DY(I)+21:POKEV=152,EX(I)+40:POKEV=153,DY(I)+21
144 POKEV=154,EX(I)+24:POKEV=155,DY(I)+21:POKEV=156,EX(I)+40:POKEV=157,DY(I)+21
145 POKEV=158,EX(I)+24:POKEV=159,DY(I)+21:POKEV=160,EX(I)+40:POKEV=161,DY(I)+21
146 POKEV=162,EX(I)+24:POKEV=163,DY(I)+21:POKEV=164,EX(I)+40:POKEV=165,DY(I)+21
147 POKEV=166,EX(I)+24:POKEV=167,DY(I)+21:POKEV=168,EX(I)+40:POKEV=169,DY(I)+21
148 POKEV=170,EX(I)+24:POKEV=171,DY(I)+21:POKEV=172,EX(I)+40:POKEV=173,DY(I)+21
149 POKEV=174,EX(I)+24:POKEV=175,DY(I)+21:POKEV=176,EX(I)+40:POKEV=177,DY(I)+21
150 POKEV=178,EX(I)+24:POKEV=179,DY(I)+21:POKEV=180,EX(I)+40:POKEV=181,DY(I)+21
151 POKEV=182,EX(I)+24:POKEV=183,DY(I)+21:POKEV=184,EX(I)+40:POKEV=185,DY(I)+21
152 POKEV=186,EX(I)+24:POKEV=187,DY(I)+21:POKEV=188,EX(I)+40:POKEV=189,DY(I)+21
153 POKEV=190,EX(I)+24:POKEV=191,DY(I)+21:POKEV=192,EX(I)+40:POKEV=193,DY(I)+21
154 POKEV=194,EX(I)+24:POKEV=195,DY(I)+21:POKEV=196,EX(I)+40:POKEV=197,DY(I)+21
155 POKEV=198,EX(I)+24:POKEV=199,DY(I)+21:POKEV=200,EX(I)+40:POKEV=201,DY(I)+21
156 POKEV=202,EX(I)+24:POKEV=203,DY(I)+21:POKEV=204,EX(I)+40:POKEV=205,DY(I)+21
157 POKEV=206,EX(I)+24:POKEV=207,DY(I)+21:POKEV=208,EX(I)+40:POKEV=209,DY(I)+21
158 POKEV=210,EX(I)+24:POKEV=211,DY(I)+21:POKEV=212,EX(I)+40:POKEV=213,DY(I)+21
159 POKEV=214,EX(I)+24:POKEV=215,DY(I)+21:POKEV=216,EX(I)+40:POKEV=217,DY(I)+21
160 POKEV=218,EX(I)+24:POKEV=219,DY(I)+21:POKEV=220,EX(I)+40:POKEV=221,DY(I)+21
161 POKEV=222,EX(I)+24:POKEV=223,DY(I)+21:POKEV=224,EX(I)+40:POKEV=225,DY(I)+21
162 POKEV=226,EX(I)+24:POKEV=227,DY(I)+21:POKEV=228,EX(I)+40:POKEV=229,DY(I)+21
163 POKEV=230,EX(I)+24:POKEV=231,DY(I)+21:POKEV=232,EX(I)+40:POKEV=233,DY(I)+21
164 POKEV=234,EX(I)+24:POKEV=235,DY(I)+21:POKEV=236,EX(I)+40:POKEV=237,DY(I)+21
165 POKEV=238,EX(I)+24:POKEV=239,DY(I)+21:POKEV=240,EX(I)+40:POKEV=241,DY(I)+21
166 POKEV=242,EX(I)+24:POKEV=243,DY(I)+21:POKEV=244,EX(I)+40:POKEV=245,DY(I)+21
167 POKEV=246,EX(I)+24:POKEV=247,DY(I)+21:POKEV=248,EX(I)+40:POKEV=249,DY(I)+21
168 POKEV=250,EX(I)+24:POKEV=251,DY(I)+21:POKEV=252,EX(I)+40:POKEV=253,DY(I)+21
169 POKEV=254,EX(I)+24:POKEV=255,DY(I)+21:POKEV=256,EX(I)+40:POKEV=257,DY(I)+21
170 POKEV=258,EX(I)+24:POKEV=259,DY(I)+21:POKEV=260,EX(I)+40:POKEV=261,DY(I)+21
171 POKEV=262,EX(I)+24:POKEV=263,DY(I)+21:POKEV=264,EX(I)+40:POKEV=265,DY(I)+21
172 POKEV=266,EX(I)+24:POKEV=267,DY(I)+21:POKEV=268,EX(I)+40:POKEV=269,DY(I)+21
173 POKEV=270,EX(I)+24:POKEV=271,DY(I)+21:POKEV=272,EX(I)+40:POKEV=273,DY(I)+21
174 POKEV=274,EX(I)+24:POKEV=275,DY(I)+21:POKEV=276,EX(I)+40:POKEV=277,DY(I)+21
175 POKEV=278,EX(I)+24:POKEV=279,DY(I)+21:POKEV=280,EX(I)+40:POKEV=281,DY(I)+21
176 POKEV=282,EX(I)+24:POKEV=283,DY(I)+21:POKEV=284,EX(I)+40:POKEV=285,DY(I)+21
177 POKEV=286,EX(I)+24:POKEV=287,DY(I)+21:POKEV=288,EX(I)+40:POKEV=289,DY(I)+21
178 POKEV=290,EX(I)+24:POKEV=291,DY(I)+21:POKEV=292,EX(I)+40:POKEV=293,DY(I)+21
179 POKEV=294,EX(I)+24:POKEV=295,DY(I)+21:POKEV=296,EX(I)+40:POKEV=297,DY(I)+21
180 POKEV=298,EX(I)+24:POKEV=299,DY(I)+21:POKEV=300,EX(I)+40:POKEV=301,DY(I)+21
181 POKEV=302,EX(I)+24:POKEV=303,DY(I)+21:POKEV=304,EX(I)+40:POKEV=305,DY(I)+21
182 POKEV=306,EX(I)+24:POKEV=307,DY(I)+21:POKEV=308,EX(I)+40:POKEV=309,DY(I)+21
183 POKEV=310,EX(I)+24:POKEV=311,DY(I)+21:POKEV=312,EX(I)+40:POKEV=313,DY(I)+21
184 POKEV=314,EX(I)+24:POKEV=315,DY(I)+21:POKEV=316,EX(I)+40:POKEV=317,DY(I)+21
185 POKEV=318,EX(I)+24:POKEV=319,DY(I)+21:POKEV=320,EX(I)+40:POKEV=321,DY(I)+21
186 POKEV=322,EX(I)+24:POKEV=323,DY(I)+21:POKEV=324,EX(I)+40:POKEV=325,DY(I)+21
187 POKEV=326,EX(I)+24:POKEV=327,DY(I)+21:POKEV=328,EX(I)+40:POKEV=329,DY(I)+21
188 POKEV=330,EX(I)+24:POKEV=331,DY(I)+21:POKEV=332,EX(I)+40:POKEV=333,DY(I)+21
189 POKEV=334,EX(I)+24:POKEV=335,DY(I)+21:POKEV=336,EX(I)+40:POKEV=337,DY(I)+21
190 POKEV=338,EX(I)+24:POKEV=339,DY(I)+21:POKEV=340,EX(I)+40:POKEV=341,DY(I)+21
191 POKEV=342,EX(I)+24:POKEV=343,DY(I)+21:POKEV=344,EX(I)+40:POKEV=345,DY(I)+21
192 POKEV=346,EX(I)+24:POKEV=347,DY(I)+21:POKEV=348,EX(I)+40:POKEV=349,DY(I)+21
193 POKEV=350,EX(I)+24:POKEV=351,DY(I)+21:POKEV=352,EX(I)+40:POKEV=353,DY(I)+21
194 POKEV=354,EX(I)+24:POKEV=355,DY(I)+21:POKEV=356,EX(I)+40:POKEV=357,DY(I)+21
195 POKEV=358,EX(I)+24:POKEV=359,DY(I)+21:POKEV=360,EX(I)+40:POKEV=361,DY(I)+21
196 POKEV=362,EX(I)+24:POKEV=363,DY(I)+21:POKEV=364,EX(I)+40:POKEV=365,DY(I)+21
197 POKEV=366,EX(I)+24:POKEV=367,DY(I)+21:POKEV=368,EX(I)+40:POKEV=369,DY(I)+21
198 POKEV=370,EX(I)+24:POKEV=371,DY(I)+21:POKEV=372,EX(I)+40:POKEV=373,DY(I)+21
199 POKEV=374,EX(I)+24:POKEV=375,DY(I)+21:POKEV=376,EX(I)+40:POKEV=377,DY(I)+21
200 POKEV=378,EX(I)+24:POKEV=379,DY(I)+21:POKEV=380,EX(I)+40:POKEV=381,DY(I)+21
201 POKEV=382,EX(I)+24:POKEV=383,DY(I)+21:POKEV=384,EX(I)+40:POKEV=385,DY(I)+21
202 POKEV=386,EX(I)+24:POKEV=387,DY(I)+21:POKEV=388,EX(I)+40:POKEV=389,DY(I)+21
203 POKEV=390,EX(I)+24:POKEV=391,DY(I)+21:POKEV=392,EX(I)+40:POKEV=393,DY(I)+21
204 POKEV=394,EX(I)+24:POKEV=395,DY(I)+21:POKEV=396,EX(I)+40:POKEV=397,DY(I)+21
205 POKEV=398,EX(I)+24:POKEV=399,DY(I)+21:POKEV=400,EX(I)+40:POKEV=401,DY(I)+21
206 POKEV=402,EX(I)+24:POKEV=403,DY(I)+21:POKEV=404,EX(I)+40:POKEV=405,DY(I)+21
207 POKEV=406,EX(I)+24:POKEV=407,DY(I)+21:POKEV=408,EX(I)+40:POKEV=409,DY(I)+21
208 POKEV=410,EX(I)+24:POKEV=411,DY(I)+21:POKEV=412,EX(I)+40:POKEV=413,DY(I)+21
209 POKEV=414,EX(I)+24:POKEV=415,DY(I)+21:POKEV=416,EX(I)+40:POKEV=417,DY(I)+21
210 POKEV=418,EX(I)+24:POKEV=419,DY(I)+21:POKEV=420,EX(I)+40:POKEV=421,DY(I)+21
211 POKEV=422,EX(I)+24:POKEV=423,DY(I)+21:POKEV=424,EX(I)+40:POKEV=425,DY(I)+21
212 POKEV=426,EX(I)+24:POKEV=427,DY(I)+21:POKEV=428,EX(I)+40:POKEV=429,DY(I)+21
213 POKEV=430,EX(I)+24:POKEV=431,DY(I)+21:POKEV=432,EX(I)+40:POKEV=433,DY(I)+21
214 POKEV=434,EX(I)+24:POKEV=435,DY(I)+21:POKEV=436,EX(I)+40:POKEV=437,DY(I)+21
215 POKEV=438,EX(I)+24:POKEV=439,DY(I)+21:POKEV=440,EX(I)+40:POKEV=441,DY(I)+21
216 POKEV=442,EX(I)+24:POKEV=443,DY(I)+21:POKEV=444,EX(I)+40:POKEV=445,DY(I)+21
217 POKEV=446,EX(I)+24:POKEV=447,DY(I)+21:POKEV=448,EX(I)+40:POKEV=449,DY(I)+21
218 POKEV=450,EX(I)+24:POKEV=451,DY(I)+21:POKEV=452,EX(I)+40:POKEV=453,DY(I)+21
219 POKEV=454,EX(I)+24:POKEV=455,DY(I)+21:POKEV=456,EX(I)+40:POKEV=457,DY(I)+21
220 POKEV=458,EX(I)+24:POKEV=459,DY(I)+21:POKEV=460,EX(I)+40:POKEV=461,DY(I)+21
221 POKEV=462,EX(I)+24:POKEV=463,DY(I)+21:POKEV=464,EX(I)+40:POKEV=465,DY(I)+21
222 POKEV=466,EX(I)+24:POKEV=467,DY(I)+21:POKEV=468,EX(I)+40:POKEV=469,DY(I)+21
223 POKEV=470,EX(I)+24:POKEV=471,DY(I)+21:POKEV=472,EX(I)+40:POKEV=473,DY(I)+21
224 POKEV=474,EX(I)+24:POKEV=475,DY(I)+21:POKEV=476,EX(I)+40:POKEV=477,DY(I)+21
225 POKEV=478,EX(I)+24:POKEV=479,DY(I)+21:POKEV=480,EX(I)+40:POKEV=481,DY(I)+21
226 POKEV=482,EX(I)+24:POKEV=483,DY(I)+21:POKEV=484,EX(I)+40:POKEV=485,DY(I)+21
227 POKEV=486,EX(I)+24:POKEV=487,DY(I)+21:POKEV=488,EX(I)+40:POKEV=489,DY(I)+21
228 POKEV=490,EX(I)+24:POKEV=491,DY(I)+21:POKEV=492,EX(I)+40:POKEV=493,DY(I)+21
229 POKEV=494,EX(I)+24:POKEV=495,DY(I)+21:POKEV=496,EX(I)+40:POKEV=497,DY(I)+21
230 POKEV=498,EX(I)+24:POKEV=499,DY(I)+21:POKEV=500,EX(I)+40:POKEV=501,DY(I)+21
231 POKEV=502,EX(I)+24:POKEV=503,DY(I)+21:POKEV=504,EX(I)+40:POKEV=505,DY(I)+21
232 POKEV=506,EX(I)+24:POKEV=507,DY(I)+21:POKEV=508,EX(I)+40:POKEV=509,DY(I)+21
233 POKEV=510,EX(I)+24:POKEV=511,DY(I)+21:POKEV=512,EX(I)+40:POKEV=513,DY(I)+21
234 POKEV=514,EX(I)+24:POKEV=515,DY(I)+21:POKEV=516,EX(I)+40:POKEV=517,DY(I)+21
235 POKEV=518,EX(I)+24:POKEV=519,DY(I)+21:POKEV=520,EX(I)+40:POKEV=521,DY(I)+21
236 POKEV=522,EX(I)+24:POKEV=523,DY(I)+21:POKEV=524,EX(I)+40:POKEV=525,DY(I)+21
237 POKEV=526,EX(I)+24:POKEV=527,DY(I)+21:POKEV=528,EX(I)+40:POKEV=529,DY(I)+21
238 POKEV=530,EX(I)+24:POKEV=531,DY(I)+21:POKEV=532,EX(I)+40:POKEV=533,DY(I)+21
239 POKEV=534,EX(I)+24:POKEV=535,DY(I)+21:POKEV=536,EX(I)+40:POKEV=537,DY(I)+21
240 POKEV=538,EX(I)+24:POKEV=539,DY(I)+21:POKEV=540,EX(I)+40:POKEV=541,DY(I)+21
241 POKEV=542,EX(I)+24:POKEV=543,DY(I)+21:POKEV=544,EX(I)+40:POKEV=545,DY(I)+21
242 POKEV=546,EX(I)+24:POKEV=547,DY(I)+21:POKEV=548,EX(I)+40:POKEV=549,DY(I)+21
243 POKEV=550,EX(I)+24:POKEV=551,DY(I)+21:POKEV=552,EX(I)+40:POKEV=553,DY(I)+21
244 POKEV=554,EX(I)+24:POKEV=555,DY(I)+21:POKEV=556,EX(I)+40:POKEV=557,DY(I)+21
245 POKEV=558,EX(I)+24:POKEV=559,DY(I)+21:POKEV=560,EX(I)+40:POKEV=561,DY(I)+21
246 POKEV=562,EX(I)+24:POKEV=563,DY(I)+21:POKEV=564,EX(I)+40:POKEV=565,DY(I)+21
247 POKEV=566,EX(I)+24:POKEV=567,DY(I)+21:POKEV=568,EX(I)+40:POKEV=569,DY(I)+21
248 POKEV=570,EX(I)+24:POKEV=571,DY(I)+21:POKEV=572,EX(I)+40:POKEV=573,DY(I)+21
249 POKEV=574,EX(I)+24:POKEV=575,DY(I)+21:POKEV=576,EX(I)+40:POKEV=577,DY(I)+21
250 POKEV=578,EX(I)+24:POKEV=579,DY(I)+21:POKEV=580,EX(I)+40:POKEV=581,DY(I)+21
251 POKEV=582,EX(I)+24:POKEV=583,DY(I)+21:POKEV=584,EX(I)+40:POKEV=585,DY(I)+21
252 POKEV=586,EX(I)+24:POKEV=587,DY(I)+21:POKEV=588,EX(I)+40:POKEV=589,DY(I)+21
253 POKEV=590,EX(I)+24:POKEV=591,DY(I)+21:POKEV=592,EX(I)+40:POKEV=593,DY(I)+21
254 POKEV=594,EX(I)+24:POKEV=595,DY(I)+21:POKEV=596,EX(I)+40:POKEV=597,DY(I)+21
255 POKEV=598,EX(I)+24:POKEV=599,DY(I)+21:POKEV=600,EX(I)+40:POKEV=601,DY(I)+21
256 POKEV=602,EX(I)+24:POKEV=603,DY(I)+21:POKEV=604,EX(I)+40:POKEV=605,DY(I)+21
257 POKEV=606,EX(I)+24:POKEV=607,DY(I)+21:POKEV=608,EX(I)+40:POKEV=609,DY(I)+21
258 POKEV=610,EX(I)+24:POKEV=611,DY(I)+21:POKEV=612,EX(I)+40:POKEV=613,DY(I)+21
259 POKEV=614,EX(I)+24:POKEV=615,DY(I)+21:POKEV=616,EX(I)+40:POKEV=617,DY(I)+21
260 POKEV=618,EX(I)+24:POKEV=619,DY(I)+21:POKEV=620,EX(I)+40:POKEV=621,DY(I)+21
261 POKEV=622,EX(I)+24:POKEV=623,DY(I)+21:POKEV=624,EX(I)+40:POKEV=625,DY(I)+21
262 POKEV=626,EX(I)+24:POKEV=627,DY(I)+21:POKEV=628,EX(I)+40:POKEV=629,DY(I)+21
263 POKEV=630,EX(I)+24:POKEV=631,DY(I)+21:POKEV=632,EX(I)+40:POKEV=633,DY(I)+21
264 POKEV=634,EX(I)+24:POKEV=635,DY(I)+21:POKEV=636,EX(I)+40:POKEV=637,DY(I)+21
265 POKEV=638,EX(I)+24:POKEV=639,DY(I)+21:POKEV=640,EX(I)+40:POKEV=641,DY(I)+21
266 POKEV=642,EX(I)+24:POKEV=643,DY(I)+21:POKEV=644,EX(I)+40:POKEV=645,DY(I)+21
267 POKEV=646,EX(I)+24:POKEV=647,DY(I)+21:POKEV=648,EX(I)+40:POKEV=649,DY(I)+21
268 POKEV=650,EX(I)+24:POKEV=651,DY(I)+21:POKEV=652,EX(I)+40:POKEV=653,DY(I)+21
269 POKEV=654,EX(I)+24:POKEV=655,DY(I)+21:POKEV=656,EX(I)+40:POKEV=657,DY(I)+21
270 POKEV=658,EX(I)+24:POKEV=659,DY(I)+21:POKEV=660,EX(I)+40:POKEV=661,DY(I)+21
271 POKEV=662,EX(I)+24:POKEV=663,DY(I)+21:POKEV=664,EX(I)+40:POKEV=665,DY(I)+21
272 POKEV=666,EX(I)+24:POKEV=667,DY(I)+21:POKEV=668,EX(I)+40:POKEV=669,DY(I)+21
273 POKEV=670,EX(I)+24:POKEV=671,DY(I)+21:POKEV=672,EX(I)+40:POKEV=673,DY(I)+21
274 POKEV=674,EX(I)+24:POKEV=675,DY(I)+21:POKEV=676,EX(I)+40:POKEV=677,DY(I)+21
275 POKEV=678,EX(I)+24:POKEV=679,DY(I)+21:POKEV=680,EX(I)+40:POKEV=681,DY(I)+21
276 POKEV=682,EX(I)+24:POKEV=683,DY(I)+21:POKEV=684,EX(I)+40:POKEV=685,DY(I)+21
277 POKEV=686,EX(I)+24:POKEV=687,DY(I)+21:POKEV=688,EX(I)+40:POKEV=689,DY(I)+21
278 POKEV=690,EX(I)+24:POKEV=691,DY(I)+21:POKEV=692,EX(I)+40:POKEV=693,DY(I)+21
279 POKEV=694,EX(I)+24:POKEV=695,DY(I)+21:POKEV=696,EX(I)+40:POKEV=697,DY(I)+21
280 POKEV=698,EX(I)+24:POKEV=699,DY(I)+21:POKEV=700,EX(I)+40:POKEV=701,DY(I)+21
281 POKEV=702,EX(I)+24:POKEV=703,DY(I)+21:POKEV=704,EX(I)+40:POKEV=705,DY(I)+21
282 POKEV=706,EX(I)+24:POKEV=707,DY(I)+21:POKEV=708,EX(I)+40:POKEV=709,DY(I)+21
283 POKEV=710,EX(I)+24:POKEV=711,DY(I)+21:POKEV=712,EX(I)+40:POKEV=713,DY(I)+21
284 POKEV=714,EX(I)+24:POKEV=715,DY(I)+21:POKEV=716,EX(I)+40:POKEV=717,DY(I)+21
285 POKEV=718,EX(I)+24:POKEV=719,DY(I)+21:POKEV=720,EX(I)+40:POKEV=721,DY(I)+21
286 POKEV=722,EX(I)+24:POKEV=723,DY(I)+21:POKEV=724,EX(I)+40:POKEV=725,DY(I)+21
287 POKEV=726,EX(I)+24:POKEV=727,DY(I)+21:POKEV=728,EX(I)+40:POKEV=729,DY(I)+21
288 POKEV=730,EX(I)+24:POKEV=731,DY(I)+21:POKEV=732,EX(I)+40:POKEV=733,DY(I)+21
289 POKEV=734,EX(I)+24:POKEV=735,DY(I)+21:POKEV=736,EX(I)+40:POKEV=737,DY(I)+21
290 POKEV=738,EX(I)+24:POKEV=739,DY(I)+21:POKEV=740,EX(I)+40:POKEV=741,DY(I)+21
291 POKEV=742,EX(I)+24:POKEV=743,DY(I)+21:POKEV=744,EX(I)+40:POKEV=745,DY(I)+21
292 POKEV=746,EX(I)+24:POKEV=747,DY(I)+21:POKEV=748,EX(I)+40:POKEV=749,DY(I)+21
293 POKEV=750,EX(I)+24:POKEV=751,DY(I)+21:POKEV=752,EX(I)+40:POKEV=753,DY(I)+21
294 POKEV=754,EX(I)+24:POKEV=755,DY(I)+21:POKEV=756,EX(I)+40:POKEV=757,DY(I)+21
295 POKEV=758,EX(I)+24:POKEV=759,DY(I)+21:POKEV=760,EX(I)+40:POKEV=761,DY(I)+21
296 POKEV=762,EX(I)+24:POKEV=763,DY(I)+21:POKEV=764,EX(I)+40:POKEV=765,DY(I)+21
297 POKEV=766,EX(I)+24:POKEV=767,DY(I)+21:POKEV=768,EX(I)+40:POKEV=769,DY(I)+21
298 POKEV=770,EX(I)+24:POKEV=771,DY(I)+21:POKEV=772,EX(I)+40:POKEV=773,DY(I)+21
299 POKEV=774,EX(I)+24:POKEV=775,DY(I)+21:POKEV=776,EX(I)+40:POKEV=777,DY(I)+21
300 POKEV=778,EX(I)+24:POKEV=779,DY(I)+21:POKEV=780,EX(I)+40:POKEV=781,DY(I)+21
301 POKEV=782,EX(I)+24:POKEV=783,DY(I)+21:POKEV=784,EX(I
```

```

475 IF(BR)THENPOKEV+21,0:GOTO300
480 IFAM<>C(1)THENGOSUB1090:GOSUB1330:GOSUB1170:GOTO365
490 GOSUB1070:POKEV+21,0:NEXTI:POKE3320,0
500 AS="(C1A):(SWLC):(BLK):(F1):(F2):1004Well Done:(F2)0310Sight Alignment(F2)1012and Aiming(F2)0314"
510 AS=AS+"Program Completed":GOSUB1060:BR=-1:GOSUB1000
520 GOTO4999
1000 AS="(SWLC):(F2)0124          <Pull TRIGGER to Begin>          ":GOSUB1060:BR=-1:GOTO1010
1003 AS="(SWLC):(F2)0024          <Pull TRIGGER to Continue>       ":GOSUB1060:BR=-1
1010 IFFER(56321)-247THENBR=0:GOTO1030
1020 IFFER(56321)<>1277THEN1010
1030 IFFER(56321)-247THEN1030
1040 AS="(SWLC):(F2)0124          ":GOSUB1060:RETURN
1060 AS=AS:SYS49102:RETURN
1070 AS="(SWLC):(RED):(F1):(F2)0513You are Correct(BLK)":GOSUB1060:GOSUB1003
1080 AS="(F1):(F2)0511          ":GOSUB1060:RETURN
1090 POKE3320,2:AS="(SWLC):(RED):(F1):(F2)0713You are Wrong":GOSUB1060:RETURN
1110 BR=-1:AS="(SWLC):(BLK):(F2)0617Pull (RED)TRIGGER(BLK) to (RED)SELECT(BLK) Answer":GOSUB1060
1112 AS="(SWLC):(BLK):(F1):(F2)0412YES(F2)3412 (GRY2):(C/LP):(C/LP):(F1)NO":GOSUB1060
1113 FORJ=0TO300:IFFER(TG)<>0THENAM=0:BR=0:GOTO1140
1116 NEXTJ
1120 AS="(F2)0412(F1) (C/LP):(C/LP):(C/LP):(F1):(SWLC):(GRY2)YES(BLK):(F1):(F2)3412NO":GOSUB1060
1125 FORJ=0TO300:IFFER(TG)<>0THENAM=1:BR=0:GOTO1140
1126 NEXTJ
1130 IFFER(TG)=0THEN1110
1140 IFFER(TG)=1277THENBR=-1
1150 AS="(SWLC):(BLK):(F2)0617          ":GOSUB1060:RETURN
1160 BR=INT(21/256):LB=21-(BR*256):POKE253,LB:POKE254,BR:POKE251,B2
1165 SYSSC:RETURN
1170 FORI=0TO7:P(I)=0:NEXTI:FORI=0TO7
1180 P=INT(RND(1)*8):IFF(P)=1THEN1180
1190 P(P)=1:DX(I)=FS(P,0):DY(I)=FS(P,1):E1(I)=FS(P,2):E2(I)=FS(P,3)
1200 DD(I)=P:NEXTI:FORI=0TO2
1210 P=INT(RND(1)*8):IFF(P)=0THEN1210
1220 P(P)=0:TX(I)=DX(P):TY(I)=DY(P):EX(I)=E1(P):EY(I)=E2(P):TD(I)=DD(P):C(I)=1
1230 NEXTI:C=INT(RND(1)*3):C(C)=0:RETURN
1250 H8="":V8="":M8="(BLK)":L8="":B8="":SP8="(RED):(F2)":OK=PX-EX(1):OY=PY-EY(1)
1251 IFLV=1THENSAS="(F2)0521Sight Alignment":F8="(SWLC):(BLK):(F1):(F2)0617Front sight is"
1252 IFLV=2THENSAS="(F2)1421Aiming":F8="(SWLC):(BLK):(F1):(F2)1417Aim is"
1255 AS=F8+SP8
1260 IFOX>0THENH8="Left"
1270 IFOX<0THENH8="Right"
1280 IFOY>0THENV8="High"
1290 IFOY<0THENV8="Low"
1292 IFH8="ANDV8="THENSAS="(BLK):(SWLC):(F1):(F2)1317This is(F2)1319(RED)CORRECT(BLK)":SAS:GOTO1310
1295 IFV8="ANDH8<"THENSAS="(BLK):(F2)1121of Center"
1296 M1=LEN(M8):M2=LEN(V8):M3=M1+M2+1:L8=" " :IFM1=0ORM2=0THENM3=M3-1:L8=""
1300 M3=20-M3:B8=STR$(M3):B8=RIGHT$(B8,2)+"19"
1310 AS=AS+B8+V8+L8+H8+M3:GOSUB1060:GOSUB1003:IF(BR)THEN4999
1320 RETURN
1330 SAS="(SWLC):(BLK):(F1):(F2)0213Sight Alignment is":P18="(F2)0619Front sight is":W=0:Q=0
1332 C18="and":C28="but"
1333 P28="(F2)0219Front sight is not":OK8="(F2)0917Correct ":OF8="(F2)0717Incorrect "
1335 POKEV+21,15:FORJ=0TO750:NEXTJ
1340 A1=P1-EX(1):A2=P2-EY(1):S1=EX(1)-X1(1):S2=EY(1)-Y1(1)
1350 IF(A1=0)AND(A2=0)THENSAS=SAS+OK8:W=1
1355 IF(A1<0)OR(A2<0)THENSAS=SAS+OF8:Q=1
1360 IF(S1=-20)AND(S2=0)THENSF8=P18:C8=C28:IFW=1THENC8=C18
1365 IF(S1<-20)OR(S2<0)THENSF8=P28:C8=C28:IFQ=1THENC8=C18
1370 AS=SAS+C8+SP8="(F2)0221Centered on Target":GOSUB1060
1375 GOSUB1003:IF(BR)THEN4999
1380 AS="(CLR)":GOSUB1060:POKEV+21,0:RETURN
4999 SYS3403:POKEV+27,0:POKE49161,3:SYS49179
5000 DATA141,139,159,139,141,119,159,137,161,119,161,141,101,119,163,141
5010 DATA101,139,163,139,101,159,163,141,161,159,161,137,141,159,163,137
6000 DATA134,126,156,126,134,106,152,124,154,106,154,127,174,106,153,127
6010 DATA176,126,152,126,174,146,156,120,154,146,154,124,134,146,156,124

```

```

*3400
; SA.3400.TXT FOR SIGHT ALIGNMENT
; AND PLACEMENT PROGRAM
JMP ENABLE
JMP DISABLE
JMP SCENE
.OPT MOL
.LIB MACROS-VARS
.OPT MOL
;020-1023 IS UNUSED IF NO CASSETTE
CTR -020
CTR1 -021
DIR -022
ENDX -023
ENDY -024
LPON -025
TRAP -026
TR -027
YMAN5 -028
CHOICE -030
STOP -031
HOLD1 -033
HOLD2 -034
HRT -035
HOLDA -036
HOLDX -037
HUMUD -038
HUMRB -039
HOLD -041
CUR -043
OFFX -044
OFFY -046
SHOTS -048
SPNUM -049
CURHOL -050
H1IRQ -051
H2IRQ -052
XVAL -053 ;X BULLET STRIKE
YVAL -055 ;Y BULLET STRIKE
SORTAP -057 ;RDGS TO SORT AFTER
STRIE -058 ;0 TO PUT IN SRTBUT
CURSRT -059
SSNUM -060
CODE1 -075
CODE2 -076
COLOR -077
HOLDY -078
PLAGE -079
LENSTR -080
TRAJ -081
CNT -082
CURCHT -083
INCX -084
OVIRQ -086
IRGRGT -087
NUMRP -088
DELAY -089
APLIRQ -091
EXTRAS -093
H3IRQ -095
H4IRQ -096
H5IRQ -097
H6IRQ -098
H7IRQ -099
RIGHT -900
OVFLO -901
TIME -902
XHVART -904
KEEPOH -906
SUMX -907
MSIZE -909
DISPLAY -910
PSNUM -911
MAXVAL -919
SPOSTX -920
SPOSTY -922
DEV -923
TRACK -925
PRDIAM -926
;NEXT ONE AT 940
BUF1 -1049
BUF2 -1099
TIMES -1149
SRTBUT -1150 ;16 BYTES
SRTBUT -1166
; NEXT ONE -1176
DEVBUF -11150
RDG881 -111200
RDG882 -111712
XBUF -12224
YBUF -12736
V -13248
SID -14272
SCRAM -11960
SCREND -12960
CHKIN -0FFFC
CHKOUT -0FFFC
CHIR -0FFFC
CLOSE -0FFFC

```

```

CLRCHW -0FFFC
CHKOUT -0FFD2
FLOAT -0B391
GETIN -0FF64
LOAD -0FFC0
OPEN -0FFC0
SETLPS -0FFBA
SETHAM -0FFAD
.MAC DINC ;DOUBLE
INC 71 ;PRECISION
BNE 72 ;INCREMENT
INC 71+1
72 .MND
.MAC DDEC ;DOUBLE
LDA 71 ;PRECISION
BEQ 72 ;INCREMENT
DEC 71+1
72 DEC 71
.MND
.MAC ADDR ;MOVE LOW
LDA 0<72 ;BYTE OF 72
STA 71 ;INTO 71 AND
LDA 0>72 ;HIGH BYTE OF
STA 71+1 ;72 INTO 71+1
.MND
.MAC PRINT
LDA 0<71
LDY 0>71
JSR $ABIE ;PRINT
.MND
.MAC PLOT
LDY 071
LDX 072
CLC
JSR $7FF0
.MND
.MAC DISK ;DISK
LDA 00 ;OPERATIONS
TAX ;LOAD"72",0
LDY 071 ;73 IS END OF
JSR SETLPS ;FILE NAME.
LDA 073-72 ;THUS LENGTH
LDX 0<72 ;OF FILE NAME
LDY 0>72 ;IS 73-72
JSR SETHAM
LDA 00
.MND
.MAC PUTR
PHA
TVA
PHA
TVA
TVA
PHA
.MND
.MAC GETR
FLA
TAX
FLA
TAX
FLA
TAX
.MND
.MAC DADD
LDA 71
ADC 72
STA 71+1
LDA 71+1
ADC 72+1
STA 71+1
.MND
.MAC DSUB
LDA 71
SEC
SBC 72
STA 71
LDA 71+1
SBC 72+1
STA 71+1
.MND
.MAC DEPL
LDA 072-71
STA LENSTR
LDA 0<71
STA $A3
LDA 0>71
STA $A4
JSR LETML
.MND
.MND
.OPT MOL
;
;PROCEDURE ENABLE
;PREPARES IRQ TO TAKE READINGS
;B:MOVE
;C:SYS ENABLE
;A:MOVE
ENABLE SEI
LDA 00
STA $6334

```

```

LDA $3265
AND 0127
STA $3265
LDA 0250
STA $3266
LDA 00
STA $3274
LDA $3273
STA $3273
ADDR 0314,START
LDA 00
STA LPON
CLI
RTS
;
;PROCEDURE DISABLE
;RETURNS IRQ VECTOR TO NORMAL
;B:MOVE
;C:SYS DISABLE
;A:MOVE
DISABLE SEI
LDA 01
STA $6334
LDA 0240
STA $3274
LDA $3273
STA $3273
ADDR 0314,$EAJ1
CLI
RTS
;
;PROCEDURE START (IRQ)
;IRQ ROUTINE TO TAKE PEN READINGS
;B,C,A:SEE AFTER, BEFORE
START LDA 00
BIT $3273
BEQ CONTIN
LDA $3273
STA $3273
JMP $7FBC
CONTIN LDA $3265
AND 0127
STA $3265
LDA 0250
STA $3266
LDA $3273
STA $3273
LDA LPON
BPL GETLP
BEQ CONT1
JMP MOVE
CONT1 JMP $EAJ1
;
;PROCEDURE GETLP (IRQ)
;TAKES PEN READINGS INTO YES/NO
;B:POKE LP,0
;C:POKE LP,M WHERE 0<M<128
;A:(X/2) READINGS STORED IN XPIN
;Y READINGS STORED AT YPIX.
GETLP JSR TRGGR
LDA TR
BEQ OUTLP1
LDA 00
STA LPON
OUTLP1 JMP $EAJ1 ; RETURN
;
;PROCEDURE TRGGR
;
TRGGR LDA $6321
CMP 0247
BNE TRG01
LDA 00
STA LION
LDA 01
STA TR
JMP TRG03
TRG01 CMP 0127
BNE TRG02
LDA 00
STA LPON
LDA 0127
STA TR
JMP TRG03
TRG02 LDA 00
STA TR
TRG03 RTS
;
;PROCEDURE MOVE (IRQ)
;MOVES SIGHTS INTO ALIGNMENT
;B:POKE CTR,$SPRITES;POKE LP,0
;C:POKE STARTING,ENDING X,Y
;A:POKE DELAY INTO CTR1
;C:POKE DIRECTION INTO DIR (0-7)
;WHERE 127<M<255 FOR TEST
;M=255 FOR DEMO
;A:POKE LP,0;RETURNS TO PROGRAM
MOVE LDA LPON ;TEST OR DEMO?
CMP 0255 ; DEMO
BNE MOVE0 ; TEST

```

```

MOVE0 JSR TRCCR : CHECK TRCCR
      LDA CTR1 : DELAY
      CMP #1 : -0?
      BCS MOVE1
      JMP OUTMV
MOVE1 LDA CTR
      LDA A
      TAX
      INX
      STX TEMP
      LDA #7 : RESTORE CTR1
      STA CTR1 : DELAY
      LDA DIR
      CMP #1
      BEQ SPMV01
      BCC SPMV00
      CMP #3
      BEQ SPMV03
      BCC SPMV02
      CMP #5
      BEQ SPMV05
      BCC SPMV04
      CMP #7
      BEQ SPMV07
      BCC SPMV06
SPMV00 JSR ADDX
      JSR CHUX
      JMP OUTMV
SPMV01 JSR ADDX
      JSR ADDY
      JSR CHUX
      JMP OUTMV
SPMV02 JSR ADDY
      JSR CHUX
      JMP OUTMV
SPMV03 JSR SUBX
      JSR ADDY
      JSR CHUX
      JMP OUTMV
SPMV04 JSR SUBX
      JSR CHUX
      JMP OUTMV
SPMV05 JSR SUBX
      JSR SUBY
      JSR CHUX
      JMP OUTMV
SPMV06 JSR SUBY
      JSR CHUX
      JMP OUTMV
SPMV07 JSR ADDX
      JSR SUBY
      JSR CHUX
      JMP OUTMV
      ADDX LDX TEMP
      ADDX1 DEX
      LDA V,X
      CLC
      ADC #1
      STA V,X
      DEX
      CPX #2
      BCS ADDX1
      RTS
SUBX LDX TEMP
SUBX1 DEX
      LDA V,X
      SEC
      SBC #1
      STA V,X
      DEX
      CPX #2
      BCS SUBX1
      RTS
CHUX LDA V+2
      CMP ENDX
      BNE CKOUT
      LDA #0
      STA LPON
      RTS
CKOUT RTS
      ADDY LDX TEMP
      ADDY1 LDA V,X
      CLC
      ADC #1
      STA V,X
      DEX
      DEX
      CPX #2
      BCS ADDY1
      RTS
SUBY LDX TEMP
SUBY1 LDA V,X
      SEC
      SBC #1
      STA V,X
      DEX
      DEX
      CPX #2
      BCS SUBY1
      RTS

```

```

CHKY LDA V+3
      CMP ENDY
      BNE CKOUT
      LDA #0
      STA LPON
      RTS
      CKOUT RTS
      OUTMV DEC CTR1
      JMP #BA31
SCENE LDA #FB : CHIP #/BANK
      STA $DFFF
      LDY #0
      LDA ($FD),Y
      STA #FB : CRUNCH CODE
      DINC #FD
      LDA #43
      STA $3265
      LDA #29
      STA $3272
      ADDR #A3,1024
SCL010 LDA ($FD),Y
      STA ($A3),Y
      DINC #FD
      DINC #A3
      LDA #A3
      CMP #<2024
      BNE SCL010
      LDA #A4
      CMP #>2024
      BNE SCL010
      ADDR #A3,0192
SCL020 LDA #FB : CRUNCH CODE
      STA ($A3),Y
      DINC #A3
      LDA #A3
      CMP #<16192
      BNE SCL020
      LDA #A4
      CMP #>16192
      BNE SCL020
      ADDR #A3,0192
SCL030 LDA ($FD),Y
      CMP #FB : CRUNCH CODE
      BNE SCL040
      DINC #FD
      LDA ($FD),Y
      STA #A3
      DINC #FD
      LDA ($FD),Y
      CLC
      ADC #>0192
      STA #A4
      JMP SCL050
SCL040 STA ($A3),Y
      DINC #A3
      DINC #FD
      LDA #A3
      CMP #<16192
      BNE SCL030
      LDA #A4
      CMP #>16192
      BNE SCL030
      LDA #32 : RAM
      STA $DFFF
      LDA #59
      STA $3265
      RTS
      .OPT LIST
      .END

```

Grouping Program Documentation

```
10 DIM XY(23,1):V=33248:SB=3409:SM=3412:CI=3415
20 DEF FWH(X)=INT(X/256):DEF FHL(X)=X-INT(X/256)*256:DEF FWR(X)=INT(RND(0)*X)
30 FOR I=0 TO 23:READ XY(I,0):XY(I,1)=NEXT
40 C08="(F1){GRN}{F2}1320CORRECT":POKE 53201,0
45 C18="(BLK){F3}162021(F1){F2}0520YES(F1){GRY3}{F2}3020no(LBLU)":C28="(GRY3){F3}162021(F2)0520yes(F1){BLK}{F2}3020NO(LBLU)"
50 POKE 2040,34:POKE 2041,34:POKE 2042,34:POKE V+29,7:POKE V+23,7
60 POKE V+39,5:POKE V+43,5:POKE V+41,5:POKE V+28,0:POKE V+16,0:POKE V+21,0
70 AS="(F6)00(F3)09(CLR){F3}01(F7)00(F1){F2}1205(GRN)GROUPING(LBLU){F2}0210good shot grouping"
80 AS-AS="(F2)0513is important to(F2)0016marksmanship":GOSUB 1000:GOSUB 1010
90 S=0:GOSUB 1050:AS="(F3)170005(F1){F2}0300Tight shot group"
100 AS-AS="(F2)11023shots hit(F2)0304 close together. (F1){F3}00":GOSUB 1000
110 POKE V,100:POKE V+1,126:POKE V+2,112:POKE V+3,134:POKE V+4,124:POKE V+5,118
120 POKE 823,7:SYS 83
130 AS="(F1){F2}1321 TIGHT ":GOSUB 1000:GOSUB 1010
140 S=0:GOSUB 1050:AS="(F3)170005(F1){F2}0301Large shot group"
150 AS-AS="(F2)0103shots hit far apart(F3)00(F1)":GOSUB 1000
160 POKE V,236:POKE V+1,119:POKE V+2,178:POKE V+3,153:POKE V+4,96:POKE V+5,123
170 POKE 823,7:SYS 84
180 AS="(F1){F2}1321 LARGE ":GOSUB 1000:GOSUB 1010
190 S=0:GOSUB 1050:AS="(F3)170005(F1){F2}0401Tight shot group"
200 AS-AS="(F2)0103shots in 4 cm circle(F1){F3}00":GOSUB 1000
210 POKE V,94:POKE V+1,118:POKE V+2,130:POKE V+3,126:POKE V+4,120:POKE V+5,110
220 POKE 823,7:SYS 85
230 POKE 864,86:POKE 865,0:POKE 866,73:POKE 863,28:SYS CI:FOR D=1 TO 1000:NEXT
240 POKE 823,7:POKE 843,112:POKE 845,122:POKE 847,184:POKE 849,158:SYS 86
250 GOSUB 1010:S=0:GOSUB 1050:AS="(F3)170005(F1){F2}0500If only 2 shots"
260 AS-AS="(F2)0302can be seen. fire(F2)0204another shot group(F3)00":GOSUB 1000
270 POKE V,0:POKE V+1,0:POKE V+2,145:POKE V+3,150:POKE V+4,111:POKE V+5,126
280 POKE 823,7:SYS 88:GOSUB 1010
290 S2=0:HC=0
300 IF HC=3 THEN 380
310 S1=FWR(8):IF (HC=2) AND ((S2 AND 15)=0) THEN S1=FWR(4)
320 IF (HC=2) AND ((S2 AND 240)=0) THEN S1=FWR(4)+4
330 IF ((S2 AND (2-S1))>0) THEN S1=S1+1:S1=S1+(S1>7)*S1:GOTO 330
340 S2=(S2 OR (2-S1)):GOSUB 1160:IF S THEN HC=HC+1
350 IF ((S2 AND 240)=2<0) THEN S2=S2 AND 15
360 IF ((S2 AND 15)=15) THEN S2=S2 AND 240
370 GOTO 300
380 AS="(F3)09(CLR){F1}{F2}1011Very good:(F2)0615standards met.(F3)00":GOSUB 1000:GOSUB 1010
390 AS="(F6)00(F3)09(CLR){F3}01(F7)00(F1){GRN}{F2}0205Would you like to:"
400 C18="(F1){BLK}{F2}0615"(F2)3115 (F2)0008Begin(F8)BAM(F8)program(GRY3){F2}2508Restart(F2)2510this(F2)2512program"
410 C28="(F1){BLK}{F2}0615 (F2)3115"(F2)2508Restart(F2)2510this(F2)2512program(GRY3){F2}0008Begin(F8)BAM(F8)program"
420 POKE V+21,0:GOSUB 1000:GOSUB 1060:IF S=0 THEN POKE 49161,2:SYS 49179
430 POKE 53272,23:POKE 53265,27:PRI:JT(CLR)":END:SYS 49176
1000 AS-AS:SYS 49182:RETURN
1010 AS="(LBLU){F3}162424(F2)0724<Full trigger to continue>":GOSUB 1000:BR=0
1020 IF PEEK(56321)=127 THEN BR=-1:GOTO 1030
1025 IF PEEK(56321)<>247 THEN 1020
1030 IF PEEK(56321)<>255 THEN 1030
1035 IF BR THEN 390
1040 POKE V+21,0:RETURN
1050 POKE 822,8:SYS 3406:POKE 53272,31:RETURN
1060 AS="(LBLU){F3}162424(F2)0524<Full trigger to select answer>":GOSUB 1000
1070 AS=C18:GOSUB 1000:S=0:BR=0
1080 IF PEEK(56321)=247 THEN S=-1:GOTO 1140
1085 IF PEEK(56321)=127 THEN BR=-1:GOTO 1140
1090 S=S+1:IF S<50 THEN 1080
1100 AS=C28:GOSUB 1000:S=0
1110 IF PEEK(56321)=247 THEN S=0:GOTO 1140
1115 IF PEEK(56321)=127 THEN BR=-1:GOTO 1140
1120 S=S+1:IF S<50 THEN 1110
1130 GOTO 1070
1140 IF PEEK(56321)<>255 THEN 1140
1145 IF BR THEN 390
1150 RETURN
1160 S=0:GOSUB 1050:S1=FWR(2)*99
1170 S4=0:X=0:Y=0:FOR J=0 TO 2:S=FWR(3)+5
1180 IF ((S4 AND (2-S1))>0) THEN S=S+1:S=S+(S>7)*(S-5):GOTO 1180
1190 S4=(S4 OR (2-S1)):POKE V+J*2,XY(S1*3+S-5,0)+23:X=X+XY(S1*3+S-5,0)
1200 POKE V+J*2+1,XY(S1*3+S-5,1):Y=Y+XY(S1*3+S-5,1):NEXT J
1210 X=INT(X/3)+23:Y=INT(Y/3)
1220 AS="(F3)170005(F1){F2}0501Is this a tight(F2)1103shot group?(F1){F3}00":GOSUB 1000
1230 POKE 823,7:SYS 88:GOSUB 1060
1240 IF ((S1>3) AND (S=0)) OR ((S1<4) AND (S=-1)) THEN 1260
1250 S=-1:AS=C08:GOSUB 1000:GOTO 1310
1260 S=0:AC=0:S=0:GOSUB 1050:AS="(F1){F2}1302(RED) WRONG (LBLU){F3}171821"
1270 IF S1>3 THEN AS-AS="(F2)0618Group will fit(F2)1120in circle(F1)":GOTO 1290
1280 AS-AJ="(F2)0618Group does not(F2)0720fit in circle(F1)"
1290 POKE V+21,7:POKE 864,X=20:POKE 865,0:POKE 866,Y=46
1300 POKE 863,28:GOSUB 1000:SYS CI:POKE 53280,2
1310 GOSUB 1010:POKE 53280,0:RETURN
8000 DATA 112,146,152,150,132,106,117,112,105,164,132,105
8010 DATA 93,146,146,193,142,100,98,193,152,182,120,129
8020 DATA 129,105,106,99,119,84,119,126,147,124,151,116
8030 DATA 120,124,136,129,131,125,120,162,136,167,110,184
```

```

-3400
;REORGANIZE.TXT
.OPT MCL
JMP ENABLE
JMP DSABLE
JMP SCENE
JMP SHBANG
JMP MOVESP
JMP CIRCLE

STOP -820
PICTUR -822
CODE1 -823
CODE2 -825
CODE3 -827
CODE4 -829
HOLD1 -831
HOLD2 -833
HOLD3 -835
HOLD4 -837
NVAL -839
YVAL -841
X1 -843
Y1 -845
X2 -847
Y2 -849
DX -851
DY -853
STEPN -855
STEPD -857
CSTEPN -859
COUNT -861
ANGLE -862
RADIUS -863
CEX -864
CEY -866
HLD1FF -868
HLD2FF -873
;NEXT ONE AT 878
LENSTR -16383
LETHL -49185
V -53248
JOYSTR -56320

.MAC DINC
INC 71
BNE 72
INC 71+1
72 .MNO
.MAC ADDR
LDA #472
STA 71
LDA #72
STA 71+1
.MNO
ENABLE CLI
RTS
DSABLE RTS
;SCENE IS CALLED TO DISPLAY ONE
;OF THE PICTURES ON THE EPROM
;PUT THE PICTURE NUMBER IN
;THE LOCATION "PICTUR" AND CALL
;THIS ROUTINE, OR USE THE MACRO
;SCRN PICTUR.
SCENE LDA #43
STA V+17
LDA #29
STA V+24
ADDR #A3.1024
SLP10 LDY #0
SLP20 LDA #177
STA (A3).Y
DINC #A3
LDA #A3
CMP #42024
BNE SLP20
LDA #A4
CMP #22024
BNE SLP20
LDX PICTUR
BNE SLP30
LDA #10
STA #DFFF
ADDR #FD.80000
ADDR #A3.0192
ADDR #TOP.16192
JBR MOVEIT
JMP SLP70
SLP30 ADDR #A3.0192
LDA #0
TAY
SLP40 STA (A3).Y
DINC #A3
LDX #A3
CPX #416192
BCC SLP40
LDX #A4
CPX #216192
BCC SLP40
LDA #11
STA #DFFF

```

```

LDX PICTUR
DEX
BNE SLP50
ADDR #FD.32768 ;TOP 1/3
ADDR #A3.10752
ADDR #TOP.13631
JBR MOVEIT
JMP SLP70
SLP50 DEX
BNE SLP60
ADDR #FD.35648 ;MID 1/3
ADDR #A3.10752
ADDR #TOP.13631
JBR MOVEIT
JMP SLP70
SLP60 ADDR #FD.38848 ;BOT 1/3
ADDR #A3.11392
ADDR #TOP.12991
JBR MOVEIT
SLP70 LDA #32
STA #DFFF
RTS
MOVEIT LDY #0
MOVEIT LDA (8FD).Y
MOVEIT STA (A3).Y
DINC #FD
DINC #A3
LDA #A3
CMP #TOP
BNE MOVEIT1
LDA #A4
CMP #TOP+1
BNE MOVEIT1
RTS
SHBANG LDA #128
STA CODE2
SHB010 LDA CODE1
AND CODE2
BEQ SHB020
LDY #255
JBR WAIT
LDY #255
JBR WAIT
LDY #255
JBR WAIT
LDA V+21
ORA CODE2
STA V+21
JBR BANG
SHB020 LSR CODE2
BNE SHB010
RTS
MOVESP LDA #0
STA CSTEPN
LDA #2
SEC
SBC X1
TAX
DX
LDA #0
SBC #0
STA DX+1
BPL MV8010
TXA
EOR #255
CLC
#1
TAX
MV8010 STX HOLD1
LDA Y2
SEC
SBC Y1
TAX
DX
LDA #0
SBC #0
STA DX+1
BPL MV8020
TXA
EOR #255
CLC
#1
TAX
MV8020 STX HOLD2
CPX HOLD1
BCC CASE1
JMP CASE2
CASE1 LDA #1
BIT DX+1
BPL MV8030
LDA #255
TAX
MV8030 STA COUNT
LDA HOLD2
STA STEP
LDA HOLD1
STA STEP
LDA STEP
COUNT
MV8040 LDA COUNT
STA HOLD3
LDA #0

```

```

STA HOLD3+1
LDX #1
BIT DX+1
JBR CRSTEP
JBR DOMOVE
LDA X1
CLC
ADC COUNT
STA X1
CMP #2
BNE MV8040
RTS
CASE2 LDA #1
BIT DX+1
BPL MV8050
LDA #255
MV8050 STA COUNT
LDA HOLD1
STA STEP
LDA HOLD2
STA STEP
MV8060 LDA #0
STA HOLD3
LDA COUNT
STA HOLD3+1
LDX #0
BIT DX+1
JBR CRSTEP
JBR DOMOVE
LDA Y1
CMP #2
BNE MV8060
RTS
CRSTEP BMI CR5010
LDA CODE1
CLC
ADC STEP
STA CSTEPN
CMP STEP
BCC CR5010
BCC CR5020
BCC CR5030
DEC X1
DEC HOLD3
CLC
ADC STEP
STA CSTEPN
INC X1
INC HOLD3
CR5010 LDA CSTEPN
STEP
CMP CR5020
BCC CR5030
JMP CR5030
CR5020 DEC X1
DEC HOLD3
LDA CSTEPN
CLC
ADC STEP
STA CSTEPN
CR5030 LDA CSTEPN
SEC
SBC STEP
STA CSTEPN
RTS
DOMOVE LDA #128
STA CODE2
LDX #14
DOM010 LDA CODE1
AND CODE2
BEQ DOM020
V, X
CLC
ADC HOLD3
STA V, X
LDA V+1, X
CLC
ADC HOLD3+1
STA V+1, X
DOM020 LSR CODE2
DEX
DEX
BPL DOM010
LDY #32
JBR WAIT
RTS
BANG LDA #13
STA #4296
LDA #10
STA #4277
LDA #30
STA #4273
LDA #128
STA #4276
LDA #129
STA #4276
RTS
WAIT LDX #255
WAIT1 DEX
BNE WAIT1

```

```

DEY
BNE WAIT1
RTS
CIRCLE LDA #0
STA ANGLE
LDA #255
STA CODE1
CIR010 LDA #0
LDY ANGLE
JSR @B391 ;FLOAT
JSR @B3CF ;FA1 TO FA2
LDA @PID180
LDY @PID180
JSR @BA2 ;MEM TO FA1
JSR @BA2B ;MULTIPLY
LDX @HLD1FF
LDY @HLD1FF
JSR @BBD4 ;FA1 TO MEM
JSR @B268 ;SINE
LDX #0
JSR @CRCOMP
LDA @HLD1FF
LDY @HLD1FF
JSR @BA2 ;MEM TO FA1
JSR @B268 ;COSINE
LDX #2
JSR @CRCOMP
LDX #0
STX HOLD1
LDX HOLD1 ;PLOT
LDA CENX ; FIRST
CLC ; QUADRANT
ADC X2,X ; VALUES
STA X1
LDA CENX+1
ADC X2+1,X
STA X1+1
LDA CENY
CLC
ADC DX,X
STA Y1
JSR BITPLT
LDX HOLD1 ;PLOT
LDA CENX ; SECOND
SEC ; QUADRANT
SBC X2,X ; VALUES
STA X1
LDA CENX+1
SBC X2+1,X
STA X1+1
JSR BITPLT
LDX HOLD1 ;PLOT
LDA CENY ; THIRD
SEC ; QUADRANT
SBC DX,X ; VALUES
STA Y1
JSR BITPLT
LDX HOLD1 ;PLOT
LDA CENX ; FOURTH
CLC ; QUADRANT
ADC X2,X ; VALUES
STA X1
LDA CENX+1
ADC X2+1,X
STA X1+1
JSR BITPLT
INC HOLD1
INC HOLD1
LDA HCLD1
CMP #2
BEQ CIR020
INC ANGLE
INC ANGLE
LDA ANGLE
CMP #44
BCS CIR030
JMP CIR010
CIR020 RTS
CIR030 STX HOLD1
CRCOMP JSR @B3CF ;FA1 TO FA2
LDA #0
LDY RADIUS
JSR @B391 ;FLOAT
JSR @BA2B ;MULTIPLY
LDX @HLD2FF
LDY @HLD2FF
JSR @BBD4 ;FA1 TO MEM
JSR @B18F ;UNFLOAT
LDA HOLD1
BOR #2
TAX
LDA #101
STA X2,X
LDA #100
STA X2+1,X
LDA @HLD2FF
LDY @HLD2FF
JSR @BA2 ;MEM TO FA1
JSR @B3CF ;FA1 TO FA2

```

```

LDA @CYORAT
LDY @CYORAT
JSR @BA2 ;MEM TO FA1
JSR @BA2B ;MULTIPLY
JSR @B18F ;UNFLOAT
LDX HOLD1
LDA #101
STA DX,X
RTS
PID180 .BYTE 123,142,250,53,17
YXRAT .BYTE 128,192,210,13,41
BITPLT LDA #0
STA #FD
STA #FE
STA #A4
LDA X1+1
BEQ P1020
CMP #2
BCS P1010
LDA X1
CMP #C320
BCC P1020
P1010 SEC
RTS
P1020 LDA Y1
CMP #200
BCS P1010
AND #248 ;INT(Y/8)*320
LDX #3
P1030 ASL
ROL
DEX
BNE P1030
STA #A3
LDX #5
P1040 LDA #FD
CLC
ADC #A3
STA #FD
LDA #FE
ADC #A4
STA #FE
DEX
BNE P1040
LDA X1 ;8*INT(X/8)
AND #248
CLC
ADC #FD
STA #FD
LDA X1+1
ADC #FE
CLC
ADC #0192 ;+0192
STA #FE
LDA Y1 ;Y AND 7
AND #7
TAY
LDA X1 ;X AND 7
AND #7
STA #A3
LDA #7
SEC
SBC #A3 ;7-(X AND 7)
TAX
LDA #1
CPX #0
BEQ P1050
P1050 ASL
DEX
BNE P1050
P1060 BIT CODE1
BPL P1070
ORA (#FD),Y
JMP P1080
P1070 BOR (#FD),Y
P1080 STA (#FD),Y
RTS
.OPT LIST
.END

```

APPENDIX H

Mathematical Formulae

The basic mathematical formulae used to calculate MACS diagnostic scores are as follows:

Steady Position	$SD(X=-45..-7) + SD(Y=-45..-7)$
Aiming	$RD(Target, X, AVG(X=-45..-7), TargetY, AVG(Y=-45..-7))$
Trigger Squeeze	$RNG(X=-6..+3) + RNG(Y=-67..+3)$
Location	$RD(TargetX, BulletX, TargetY, BulletY)$

SD is an abbreviation for standard deviation; thus, the steady position score is the standard deviation of the X axis readings for the 45th to 7th reading before trigger closure. This is added to the standard deviation of the Y axis readings.

RD is an abbreviation for radial distance. It is simply the Pythagorean formula: the square root of the difference in the X values, squared, plus the difference in the Y values, squared. In the aiming measure, the average X and Y values (AVG) over the time window are subtracted from the target X and Y values. In the shot location measure, the bullet strike X and Y values (defined as the last reading taken before trigger squeeze, or -1) are subtracted from the target X and Y values.

RNG is an abbreviation for range. It is simply the difference between the maximum value and the minimum value. The time window for the trigger squeeze score is from 6 readings before trigger closure through 3 readings after trigger closure.

A factor of 1.6 is multiplied to the Y axis scores in each of the above formulae to compensate for the greater length of actual pixels in the Y axis. The mathematical standards are shown in Table H-1 below. S signifies the actual score.

Table H-1

Standards in the BRM Program for Diagnostic Scores and Shot Location

<u>Supported Position</u>	<u>Excellent</u>	<u>Good</u>	<u>Average</u>	<u>Below Average</u>	<u>Poor</u>
Steady Position	$0 \leq S \leq 2.5$	$2.5 < S \leq 5$	$5 < S \leq 8$	$8 < S \leq 10.5$	$10.5 < S$
Aiming	$0 \leq S \leq 1.6$	$1.6 < S \leq 3.5$	$3.5 < S \leq 6.5$	$6.5 < S \leq 9$	$9 < S$
Trigger Squeeze	$0 \leq S \leq 2.5$	$2.5 < S \leq 5$	$5 < S \leq 8$	$8 < S \leq 10.5$	$10.5 < S$
Shot Location	$0 \leq S \leq 1.6$	$1.6 < S \leq 3.5$	$3.5 < S \leq 6.5$	$6.5 < S \leq 9$	$9 < S$
<u>Unsupported Position</u>	<u>Excellent</u>	<u>Good</u>	<u>Average</u>	<u>Below Average</u>	<u>Poor</u>
Steady Position	$0 \leq S \leq 4$	$4 < S \leq 6.5$	$6.5 < S \leq 9.5$	$9.5 < S \leq 12$	$12 < S$
Aiming	$0 \leq S \leq 2$	$2 < S \leq 4.5$	$4.5 < S \leq 8$	$8 < S \leq 11$	$11 < S$
Trigger Squeeze	$0 \leq S \leq 4$	$4 < S \leq 7$	$7 < S \leq 11$	$11 < S \leq 14.5$	$14.5 < S$
Shot Location	$0 \leq S \leq 2$	$2 < S \leq 4.5$	$4.5 < S \leq 8$	$8 < S \leq 11$	$11 < S$

Breath control is "OK" if steady position is excellent, good or average. "Check" is displayed if steady position is below average or poor. The breath control score is presented in the same color as the steady position score.

END

FILMED

1-90

DTIC